Freshwater Conservation Measures for the Northern Great Plains Steppe Ecoregion of Montana

Prepared for:

The Nature Conservancy, Ecoregional Measures Team and The Montana Field Office

By:

David M. Stagliano
Aquatic Ecologist

Montana Natural Heritage Program
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Executive Summary

Project goals of the Freshwater Ecoregional Measures for the Northern Great Plains Steppe (NGPS) are to: 1) identify and reevaluate the number, diversity and viability of aquatic target occurrences within the Montana portion of the NGPS Ecoregional Plan based on a suite of indicator-based measures set within the aquatic ecological system framework, and 2) determine biodiversity viability measures (for the aquatic ecological system types, or for target species), threat status, and protection of these targets within the portfolio sites of the Ecoregional Plan. Using a combination of field data and GIS data layers, we analyzed the intersection of portfolio sites, 5th code watersheds, target occurrences, and indicator measures (viability, threats, and protection) to form an effective conservation map of selected MT portfolio sites in the NGPS.

Overall, 34 of Montana's 43 native fish species reside within the NGPS ecoregion. Nine of these are MT Species of Special Concern (SOC), one of which is listed Endangered by the USFWS and four are potential species of concern (PSOC). All of these fish species, except one have at least one viable occurrence within MT's portfolio sites. The 15 types of prairie aquatic ecological systems (8 biological) are well represented within the portfolio, including associated aquatic macroinvertebrate communities with their SOC species. Threats in the portfolio with the broadest scope and severity are agriculture and surface diversions in the watersheds, while the most pervasive moderate level threats are riparian grazing and presence of northern pike, an introduced piscivorous fish.

Effective conservation of aquatic systems in the NGPS portfolio sites in MT is quite low. Six of the 68 (8.9%) evaluated 5th code HUCs representing only two of eight aquatic ecological systems, and only 529 river miles are effectively conserved; if compared to the total river miles in the portfolio sites; this represents only 1.8% of those available. If we consider the criteria of Permanently Secured-Low Threat Viable Watersheds without effective management then the number of 5th code HUCs increases to 24 of the 68 (35%) or 30.6% of the portfolio area. A large percentage of the aquatic ecological systems within the portfolio sites (50 of 68 fifth-code HUCs) have good to excellent viability with moderate to low synergistic threats. Lack of effective land management is the main reason for the paucity of effectively conserved watersheds, because a large proportion of these portfolio sites are still in "unmanaged public" (48%) or privately-held lands (~43%). Additionally, our analysis revealed that watersheds with high percentages of "effectively managed" lands (GAP 1+2) did not necessarily correlate with higher biointegrity (viable) aquatic systems. We found watersheds with higher percentages of private lands and more agriculture had a significantly greater chance of being viable and higher in biointegrity. This is quite contradictory to previous studies. We did not find clear relationships between the broad-scale conditions and fine-scale assessments. Many of the landscape level threats seemed unrelated to the condition of the aquatic communities in the watershed. Localized impacts and reach-scale community attributes typically took precedence over watershed-level condition. Presence of introduced species and especially the piscivorous, northern pike lowered the integrity of watershed sites (based on the IBI and O/E model), so an abundance of these species will adversely affect the viability rank of the aquatic system regardless of the landscape condition.

We identified critical aquatic sites in the portfolio that should be targeted for "effective conservation," as these will accomplish conservation of all lotic aquatic biodiversity present in the Northern Great Plains Steppe of Montana.

Acknowledgements

We would like to thank the Montana Field Office of the The Nature Conservancy, especially Brian Martin and Bee Hall for recommending that the MT NHP program conduct this study. Also needing thanks for funding, initiative and guidance along the way are Jonathan Higgins and Jamison Ervin of the Conservation Measures Team who allowed us to proceed on this pilot project with freshwater measures in Montana. Much of the GIS analysis and map production was thoroughly and expertly accomplished by Jane Horton and Karen Walker, respectively of the Montana Natural Heritage Program (MTNHP). Maps looking less professional were produced by the author. The report reviewer with always helpful comments was Linda Vance, and report formatting was provided by Coburn Currier (MTNHP).

All photos in the report were taken by MTNHP personnel, unless otherwise noted.

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INTRODUCTION

The Northern Great Plains Steppe Ecoregion covers parts of five states and two Canadian provinces and encompasses approximately 250,000 square miles; 83,200 sq. mi. or ~33% of this ecoregion occurs in Montana (Figure 1). With the identification of portfolio sites in the Northern Great Plains Steppe (NGPS) Ecoregional Assessment Plan (TNC 1999, recent revisions), Martin et al. have distilled out the most ecologically significant areas of this ecoregion. In Montana, the portfolio sites equal 16.98 million acres (26,535 sq. mi.) or about 32% of Montana's NGPS ecoregion (Figure 1). Acreage is roughly 45% in the Northwestern Glaciated Plains and 55% in the Northwestern Great Plains.

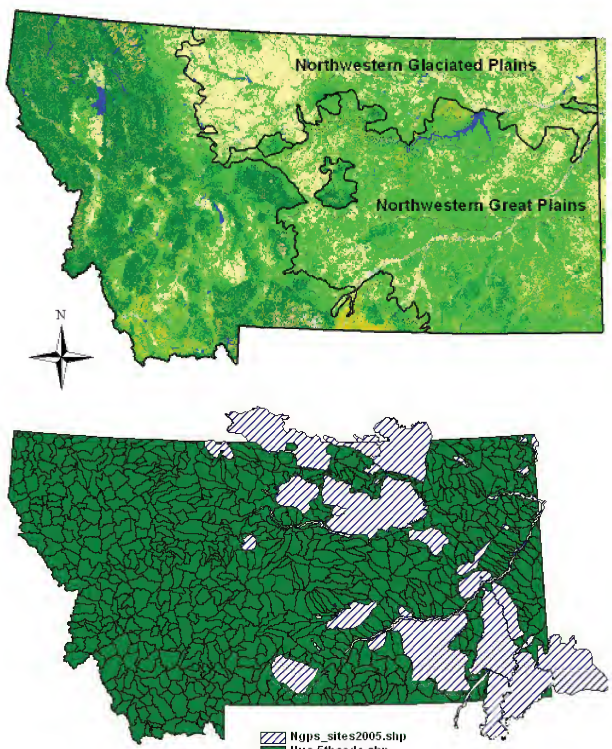


Figure 1. Montana's Northwestern Great Plains and Northwestern Glaciated Plain sections of the NGPS ecoregion (top). TNC NGPS Portfolio Sites and 5th code watershed HUCs (bottom).

Following Nature Conservancy standards and guidelines, the NGPS Ecoregional Assessment team set quantity and distribution goals for targeted species, communities, and ecological systems based on conservation status and distribution in the ecoregion. Unfortunately, the NGPS plan was finished before an intensive evaluation and classification of the Upper Missouri River Basin aquatic communities and ecological systems was completed. Prairie streams systems throughout North America have suffered neglect due to a lack of comprehensive study and understanding (Dodds et al. 2004, Matthews 1988). Only recently have there been efforts to sample and describe the interactions among Montana's prairie stream aquatic biota, and to relate prairie system aquatic communities to their landscapes; unfortunately very little attention has been directed towards the other prairie freshwater habitats (wetlands, ponds and lakes). The purpose of this study is to evaluate the inclusion of aquatic ecosystem diversity in the Montana portion of the NGPS ecoregional plan and to prioritize systems and sites for the "effective conservation" of aquatic biodiversity in the ecoregion.

The general model for integrating freshwater aquatic targets into ecoregional planning includes five steps (Olivero et al. 2003, TNC 2000):

1. Develop a general understanding of the variety and distribution of aquatic ecosystems and aquatic species patterns present in the ecoregion.
2. Identify and locate aquatic targets (species, communities, and aquatic ecological systems).
3. Select the best examples of aquatic targets that represent the full diversity of aquatic ecosystems in the ecoregion.
4. Incorporate aquatic targets with terrestrial targets to design the ecoregional portfolio.
5. Identify information gaps and strategies to address them.

The initial inclusion of lotic aquatic communities in NGPS Plan largely circumvented Step 1 and was based on the TNC aquatic coarse filter tool (see Figure 2). The primary and secondary fine–scale aquatic targets were analyzed separately using dated, non-comprehensive MT Fish, Wildlife and Parks & Natural Heritage Program data. Overall, the selection of areas for protection in Montana has been largely based on terrestrial features and has

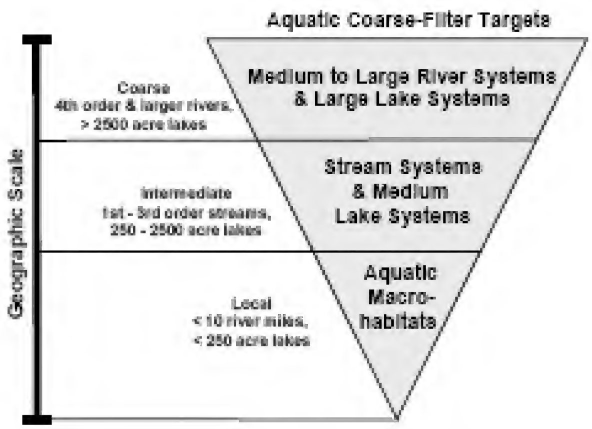


Figure 2. Aquatic target selection using TNC coarse-filter.

not taken into account representative examples of all NGPS aquatic systems.

Since the publication of the NGPS Plan, 38 Aquatic Ecological System (AES) types (following Higgins et al. 2005) were identified in the Upper Missouri River Basin, 15 of which occur in the Northern Great Plains Steppe Ecoregion. Of these AES types, eight were scientifically validated with distinct biological species associations (Table 1, Stagliano 2005). These 15 AES types (eight biological) represent the whole of lotic aquatic diversity available in the Montana portion of the NGPS, and are quite transferable to other areas of the ecoregion (Stagliano 2006).

Only two of these ecological system types (Large Valley and Large Prairie River Systems) were considered primary targets for the initial NGPS ecoregional plan. Additionally, 4 globally uncommon to rare (G1-G3) large river mayflies were documented and placed on the SOC list since 2000 (MTNHP 2006), as well as habitat specialist dragonflies, from the large-valley prairie rivers of Montana that will now be tracked by MTNHP to assist in conservation area protection (Appendix A). Therefore, a direct link could now be made

Table 1. NGPS Aquatic Ecological System types, occurrences in the database and the biological community groups (SPA) associated with the defined aquatic ecological communities. MCIN=Aquatic Macroinvertebrate Communities (see Stagliano 2005 for species lists).

Aquatic Ecological System	AES types	Fish SPA	MCIN SPA	Number of Occurrences*
Large Valley River Ecosystem	**A001, A002**	**1, 2, 5**	**3, 11, 37, 38 40, SDM****	**26, 35**
Large Prairie River Ecosystem	**A003, A004**	**1, 2, 3, 9**	**3, 11, 37, 40, SDM**	**20, 11**
Medium Prairie River Ecosystem	**B005, B006 B008**	**1, 2, 18, 20**	**9, 11, 37, 38, 40**	**82, 44 6**
Great Plains Prairie Stream Ecosystem	**C005**	**2, 9, 20**	**9, 12**	**115**
Northern Glaciated Prairie Stream Ecosystem	**C006, C008**	**2, 4, 18, 20**	**9,12**	**74, 29**
Great Plains Intermittent Stream Ecosystem	**D005 E005**	**20, 26 None**	**12**	**126 25**
Northern Glaciated Intermittent Stream Ecosystem	**D006 E006**	**18, 20 None**	**9, 12**	**101 19**
Small Fishless Prairie Spring Ecosystem	**S005**	**None**	**1, 12**	**26**

* Number of Occurrences by AES type in the database, based on one or both biological groups
** **SDM=sand-dwelling mayfly group**

from the AES to species associations and finally to fine-scale, individual target species information. Having a robust aquatic classification system can enhance conservation efforts by highlighting rare community types, or those aquatic ecological types that are more likely to contain species of concern or the full compliment of native species. Ecosystem classification provides a way to understand the complexity of ecosystems and creates distinctions among ecosystem types based on factors that determine the distribution of ecological processes and biota (Hawkins and Norris 2000). We classified biological communities (fish and macroinvertebrates) within the Missouri River Zoogeographic Region with respect to the common repeatable habitat units within the watersheds that they occur. The process of developing an "a posteriori" community classification framework involves compiling the best available information and integrating biological assemblages onto an "a priori" derived watershed template, as described by Higgins et al. 2005. Identifying the diversity and number of viable aquatic ecological systems is critical for effective conservation. Efforts to identify aquatic features in need of conservation and protection have been hampered by a lack of knowledge on the variety and distribution of aquatic species, communities and systems on a watershed basis. In the NGPS of Montana, we feel knowledgeable enough to begin steps towards effective conservation of these aquatic systems. For example, within the Northwestern Glaciated Plains subsection of the NGPS, high-quality Northern Glaciated Perennial Prairie Streams (AES C006) are predicted to contain the Pearl Dace (MT SOC) ~25% of the time. Therefore, at the AES scale at least 4 reaches of this stream type should be included to probabilistically contain a single pearl dace population.

Linking Targets from Ecoregional Assessments and Conservation Projects

TNC proposes to conduct assessments of indicator-based measures in FY06 and in subsequent decades so that we may discern long-terms trends in our target's viability, threat status, and protection status. This process will use both indicators and status measures of biodiversity. As described in Ervin (2002), an analysis of threats and stressors is an important component of a rapid assessment of the overall management effectiveness of protected areas within a particular country or region. We also propose to aggregate those same indicator-based measures into Effective Conservation ranks for each occurrence to compare with our ecoregional goals (as per Ervin 2002). Identifying conservation targets is perhaps one of the most important parts of the Conservation Approach. The relationship between Conservation Projects and ecoregional assessments has been inconsistently addressed across TNC. A direct, spatially explicit relationship is needed for the Conservancy to build better conceptual and practical links between the various conservation targets identified as priorities for conservation at these different spatial scales (Ervin 2006). Since funds for this pilot project are limited, we focused our attention on areas identified in the portfolio sites that also have existing conservation projects or potential near-future projects (Figure 3).

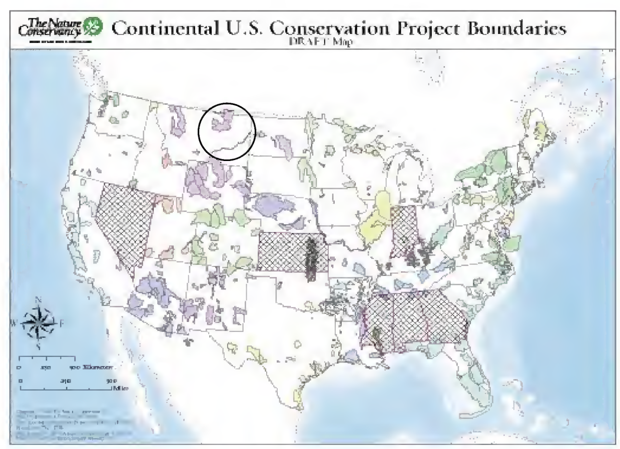


Figure 3. DRAFT map of Conservation Project boundaries for the continental U.S. The color of the boundaries has no significance. The states with cross-hatches have not submitted spatial data yet.

We chose to evaluate the Portfolio Sites: Montana Glaciated Plains, Hell Creek Badlands, Whitewater Wetlands, Frenchman/Bitter Creek, Sage Creek/SW Pastures which contain 7,760,968 acres. Three of the five MT portfolio sites border Canada (73% of these occur in MT, the remainder in Canada) (Figure 4).

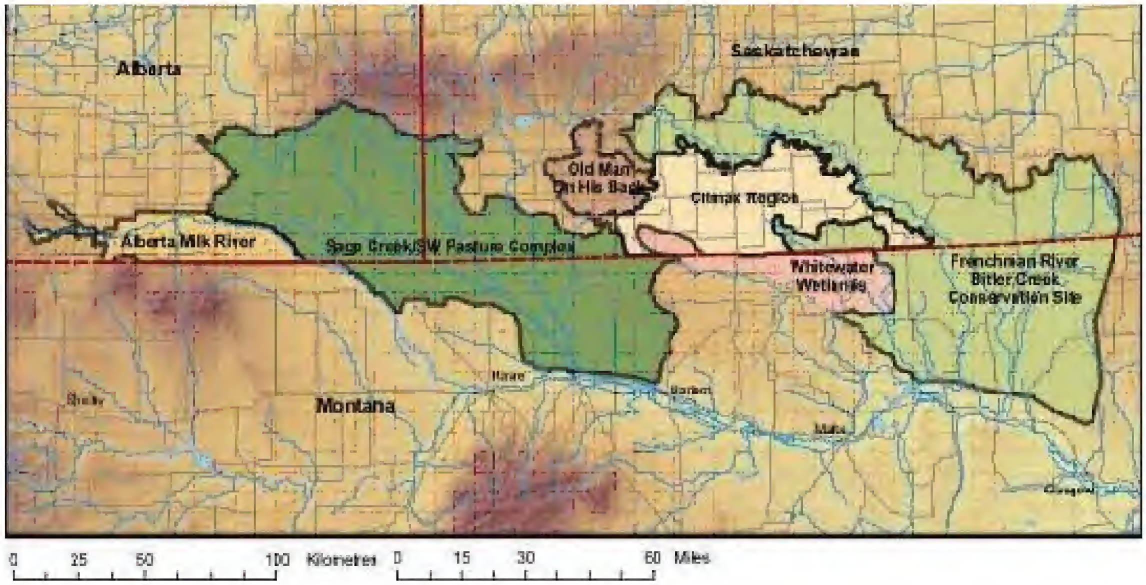


Figure 4. International border portfolio sites

We evaluated the effective conservation of significant aquatic sites as they pertain to the goals for targets within the Northern Great Plains Steppe ecoregion using Aquatic Ecological Systems as the basis. Our outcome measures address a set of key conservation questions grouped into two categories: (1) Assessing the status of biodiversity, threats, and the overall capacity to improve conservation; and (2) Measuring the effectiveness of the strategies TNC is implementing. "By allowing us to measure trends in the status of biodiversity, threats, and capacity over time, these measures help us to set and re-evaluate priorities in an ecoregion and to assess the need for, and feasibility of, specific conservation projects" (Ervin 2005). Ecoregional status measures will enable comparisons across ecoregions and allow the tracking progress toward our 2015 year goal. With the new 2015 "Effective Conservation" goals set for The Nature Conservancy, how we measure effective conservation depends in large part on the status measures of viable biodiversity, acceptable threat levels, and adequate conservation management in any given region (FAQ at ConserveOnline).

On the whole, the NGPS Ecoregional Conservation Plan has included a large swath of untilled prairie area in the Level III Northwestern Great Plains ecoregion. Because intact watershed landscapes at the regional scale have been shown to support aquatic communities with high biological integrity (Bramblett et al. 2005, Allan 2004, Allan et al. 1997), we expect aquatic ecological systems within these high integrity watersheds to maintain long-term viability. To determine if this were true, we used an aquatic ecosystem classification approach developed by the Montana Natural Heritage Program (Stagliano 2005) coupled with surrogate measures of biodiversity (IBI's, O\E, etc.) to address the diversity and viability of aquatic ecological systems within the portfolio sites of Montana's NGPS.

Methods

Measuring Viable Biodiversity

The viability of a conservation target is the degree to which a target occurrence has the potential to persist, and contribute towards ecoregional goals for target redundancy and resilience. For aquatic systems within the NGPS, the traditional method of determining aquatic conservation goals was utilized (systems-coarse filter targets, and species-fine filter targets: Olivero et al. 2003, TNC 1999; see figure 2). In areas that have not been classified with the Freshwater Classification (following Higgins et al. 2005), this system has largely relied on best professional judgment, and Natural Heritage Program data for target species of special concern. Unfortunately, inventory on the prairie streams has lagged behind mountain lotic systems in Montana, and most of our knowledge of the prairie streams of the NGPS has been gained in the past few years (Bramblett et al. 2005, Stagliano 2005, FWP 2005). Therefore, intensive evaluation and biointegrity analysis of the Upper Missouri River basin aquatic communities and ecological systems has been recently undertaken and ongoing. Surrogate measures of aquatic biological community viability were calculated or inferred at all study sites using Fish Integrated Biotic Indices (FIBI, Bramblett et al. 2005), Observed/Expected Models (O/E, Stagliano 2005 and unpublished report), as well as macroinvertebrate multi-metrics (MT MMI) and Statewide Reference Streams (DEQ 2005, Supple et al. 2006). These metric-based approaches use attributes of the biological community expected to change in predictable ways given specific anthropogenic impacts (Barbour et al. 1999, Karr and Chu 1999). The impairment threshold set by MT DEQ for the MT MMI is **37** for the Eastern Plains Stream Index; any scores above this threshold are considered unimpaired, scores of 36-28 indicate moderate impairment or fair integrity, and those <28 are considered severely impaired or low biological integrity (Feldman 2006). If the index score is below the impairment threshold, the individual metrics can be used to provide insight as to why the communities are different from the reference condition (Barbour et al. 1999, Jessup et al. 2005). For the Observed/Expected (O/E) scores, taxa in the sample were compared to their expected community indicator species for that classified prairie aquatic ecological type (Stagliano 2005) and the percent similarity drives the threshold with O/E scores >0.80 considered good to excellent biological integrity, 0.79 -0.44 considered moderately impaired or fair integrity and scores <0.44 severely impaired or poor integrity (Feldman 2006, Appendix B).
Bramblett et al. (2005) did not propose threshold criteria for good, fair, and poor biological integrity for the prairie fish IBI scores. Therefore, we applied commonly used criteria. Scores of 75 to 100 indicate good to excellent biological integrity "A" score, 50-74 good biological integrity "B", 25 to 49 indicated poor to fair integrity "C" and scores <25% indicate poor biological integrity or severely impaired "D". This analysis was performed on all samples within the 5th code-level watershed (HUC). Multiple data points within the HUC were averaged to determine an overall HUC integrity index.
If conflicting results in biointegrity measures occurred at a single site (macroinvertebrate MMI vs. fish IBI), we generally defaulted to the fish community scores because the macroinvertebrate MMI is still undergoing field testing for accuracy and discrimination analysis (Feldman 2006, pers. comm.). This integrity index was categorized as A (excellent), B (good), C (Fair), D (Poor), E (no/low quality data) viability in keeping with the NatureServe ranking system of element occurrences (EOs, Table 2), but it does not imply that we actually ranked the aquatic ecological systems with the intensive Natureserve criteria, instead it was only a starting point for analysis.

Table 2. Ranking system for the fine-scale (EO's) targets (Nature Serve 1999).

EO Rank	Description of Ecological Integrity
A	excellent
B	good
C	fair
D	poor
E	verified extant (integrity not assessed)
H	historical (not recently located)
X	extirpated (no longer extant)

Measuring and Assessing Threats

The common threats taxonomy provides a vocabulary for assessing threats to biodiversity worldwide (Appendix D). A "threat" is any human activity or process that has caused, is causing or may cause the destruction, degradation and/or impairment of biodiversity and natural processes (Salafsky et al. 2003). This taxonomy guided our evaluation of threats to our particular subsection of the NGPS ecoregion. The broadscale ecoregional threats assessment has already been taken into account in the derivation of these portfolio sites (TNC 1999). From this analysis, the top four NGPS ecoregional threats were 1) inappropriate grazing management, 2) loss of fire regime, 3) exotic species and 4) habitat conversion to agriculture with oil/gas and hydrologic alterations rounding out the top 6. At the local scale, grazing and livestock use around the riparian areas occurs and can have strong local effects resulting in sedimentation, nutrient additions and stream widening at cattle crossings. Introductions of game or forage fish in stock ponds anywhere in the watershed can infiltrate upstream or downstream areas to larger prairie rivers and become permanent residents, competing with (e.g. green sunfish) or preying upon (e.g. northern pike) resident native fish species. Therefore the number of dams in a HUC could also be indicative of introduced species colonization points.

Approaches to assessing threats, therefore, can vary considerably, depending on the scale and objectives of the assessment. At a site or portfolio level, TNC measures a threat relative to the degree to which it affects key ecological attributes of conservation targets within the area. For aquatic ecosystem analysis in the NGPS, previous studies (Bramblett et al. 2005, Stagliano 2005) have led us to determine that significant threats with the highest potential to disrupt natural processes and impair biodiversity in the prairie ecosystems of Montana include: 1) dams and diversions (hydrologic disturbances), 2) roads in the watershed, 3) altered land cover (habitat conversion and degradation) and 4) introduction of harmful aquatic species. The GIS screening analysis was used as a surrogate, but standardized, method of evaluating current condition of threats to the aquatic ecosystems. It used landscape variables such as percent grazing in the riparian, road density, density of road/stream crossings, percent agriculture, dam and diversion density and oil and gas wells. We evaluated the first 3 threat types using commonly available GIS data layers (Montana NRIS 2006) for a selected group of portfolio sites with analysis techniques based on Vance (2005). Specific threats were assessed as follows:

Riparian Grazing Threat Index

Grazing pressure is substantial throughout the study area. While the number of grazing stock has been reduced in response to drought conditions over the past 5 years, much of the range is heavily utilized. Similarly, modification of streams for stock pond watering has been carried out extensively, and these watering holes tend to concentrate both traffic and grazing pressure into specific areas (Vance 2005).

• Select all polygons within the 50m buffered stream corridor of all streams within the 5th code HUC layer indicated as having natural cover in the National Land Cover Dataset;
• Overlay the public and private grazing lands layer on this natural land cover riparian corridor layer;
• Sum all natural land cover acres within public and private grazing lands layer.
• Total riparian grazing acres were divided by the HUC acres to determine a % of grazing in the watershed. Assign the grazing percentages a HUC grazing threat score (Table 3).

Oil and Gas Wells

• Create an oil and gas well data layer from the NRIS digital atlas site (Figure 5).
• Overlay the oil and gas point data layer on the 5th code HUC USGS watershed layer;
• Sum the number of points that occur within the 5th code HUC watersheds within the portfolio sites and code them with the appropriate threat code (Table 3).

Dams and Surface Diversions

Both dams and surface water diversions change the hydrologic flows in a watershed, and deprive riparian communities of the water needed for proper ecological functioning.

Figure 5. Oil and gas well locations (red points) within the northern NGPS.

During recent decades, scientists have amassed considerable evidence that a river's natural flow regime, its pattern of high and low flows throughout the year as well as across many years, exerts great influence on river health (Postel and Richter 2003). Dams also trap fine sediments, disrupting normal geomorphic processes downstream, and alter the substrate behind them. Reservoirs behind dams are usually point sources of stocked or introduced exotic species affecting food chain dynamics of the native fishes both upstream and downstream. This counting method of assessing dams and surface diversions, while not completely capturing the impact of diversions and withdrawals, at least gives a basis for comparing the degree of stream alteration between the 5th code HUCs.

• Create a dams layer and a non-dam diversion layer from the Montana Water Rights layer;

• Overlay the dams and non-dam diversion layers on the USGS National Hydrography Dataset 1:100,000 streams layer (Figure 6);

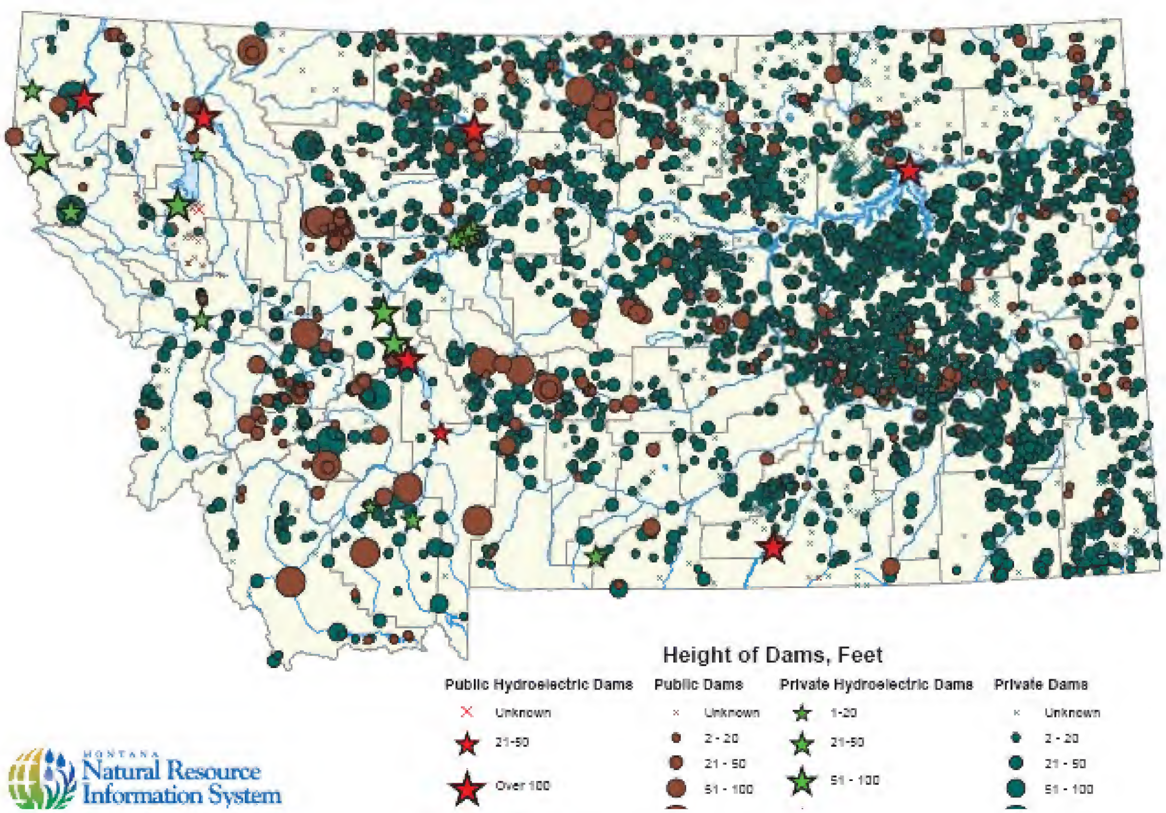


Figure 6. Dam locations by size and ownership within MT

• Sum the number of dams or non-dam diversions that intersect streams in the 5th code HUC watershed within the portfolio sites and code them with the appropriate threat code (Table 3).

Measuring Road Disturbances

Both improved and unimproved roads compact soil and vegetation, increasing surface runoff. Road rights of way are often inroads for exotic species colonization points, and unimproved roads contribute to wind and water-borne sedimentation. Streams in close proximity to roads are more likely to be affected by roads than those at a greater distance. We chose the 40 meter buffer instead of a larger and more conservative buffer only because roads in the area are lightly traveled, and many are simply two-tracks in the prairie.

• Buffer all mapped streams in the watershed by 40 meters on each side;

• Sum acres of miles of stream within the 40 meter road buffer zone.

For the study area and 5th code HUCs, the percentage of stream miles within 40m of a road are generally low indicating that roads may not be a major source of disturbance in the study area (Table 3). The highest scores, predictably, are in the watersheds with the greatest road density, and it might be just as effective to use road density itself as an index, rather than buffering and overlaying roads on streams.

Agricultural Threat Index

Negative impacts to aquatic life may occur when ~30 to 60% of a basin's land area is in agricultural use (Sheeder and Evans 2004; Zheng et al. 2005), but if proper riparian buffers are maintained, much of agriculture's effects may not be translated into harmful aquatic effects (Wenger 1999). Therefore, a more important measure of this threat is % agriculture within a certain distance of a stream. To quantify this threat we proceeded to:

• Create an agricultural land cover layer from the National Land Cover database;

• Overlay the agricultural land cover layer on the natural communities layer to identify the types of natural communities most susceptible to agricultural conversion within the 40m buffer zone along all streams in the HUC;

• Sum acres of buffered stream within that layer and divide by the acres of the HUC for % agriculture

Seven variables: percent riparian grazing, percent agriculture land, % stream miles within 40m of a road, road crossings, number of dams and surface diversions, and oil and gas wells in the watershed area, were concatenated to develop an overall threat rank for each 5th code watershed.

See Table 3 for the landscape context component rank criteria. The overall HUC Threat Rank was determined by the additive method and synergistic method (see Appendix E).

Table 3. Watershed Landscape Context Rankings. %Ag= percent agriculture (described in Methods)

Threat Rank	Coded Rank	% Ag	% Grazing	% Stream miles within 40m Rd	# of Road Crossings per HUC	# of Dams in HUC	# of Oil & Gas Wells	# of Surface Diversions
No	**0**	0	0	0	0	0	0	0
Low	**1**	<3%	<3%	<1	<10	>1-5	>1-10	<50
Moderate	**2**	3-6%	3-6%	1-2.5	>10-25	>5-10	>10-20	50-100
High	**3**	6-10%	6-10%	2.5-3.5	>25-50	>10-14	>20-50	100-150
Severe	**4**	>10%	>10%	>3.5	>50-100	>14	>50-100	150-200
Very Severe	**5**				>100	>15	>100	>200

Exotic/Introduced Species

Piscivorous introduced fish species have been shown to disrupt native fish community structure and even eliminate species altogether (Moyle and Leidy 1992, White et al. 2001). Populations of introduced northern pike have been causally implicated in the extirpation of many populations of Montana's native prairie fish fauna (Bramblett 2004, Stagliano 2005, MFISH database 2006), and their movements into tributary streams of any Upper Missouri River watersheds has likely contributed to native prairie fish populations becoming locally extirpated. The main question to address in the viability/threats portion of the study is "Are the presence of northern pike populations in any watershed impacting the biointegrity (viability) of the system and impeding the potential of native prairie fishes to persist in the watershed, or are other water quality and in-stream habitat factors involved?" Although northern pike are native to the Saskatchewan Drainage of Montana (Holton 2003), all populations in the Missouri River drainages are introduced, usually intentionally (FWP Stocking or by bait bucket introductions). The Nature Serve website (Nature Serve 2006) identifies all 4th code drainages within the MT NGPS Portfolio sites as possessing occurrences of the northern pike (Figure 7).

Thus, it is difficult to assess an overall threat status if all watersheds are under a similar perceived threat. Therefore, we assigned each 5th code HUC within the larger 4th code watersheds a threat rating (low-1, moderate-2, high-3) based on the abundance of pike occurrences in actual samples analyzed from the Heritage/FWP databases. A 5th code HUC without sampled pike occurrences still received a 1 due to the underlying threat of pike occurring in the larger watershed and colonization into smaller prairie stream tributaries is a very real possibility. Moderate pike threat was assigned to the 5th code HUC when consistent occurrences of low-numbers of pike were reported in the data. High pike threat (3) was assigned to HUCs where

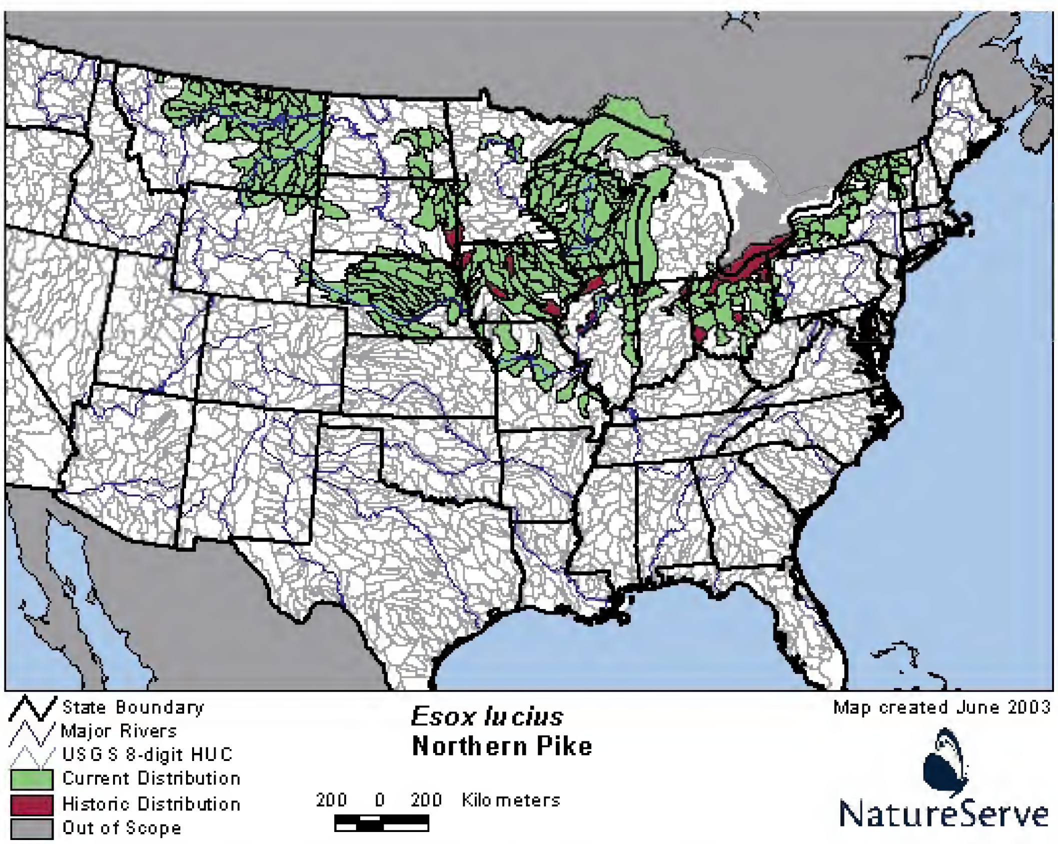


Figure 7. Northern pike distribution by 4th code (8-digit) watershed

consistent occurrences of moderate-high numbers of pike were reported in the watershed data.

Some of the other occurring introduced species (i.e., green sunfish & black bullhead) were absent from many of the 5th code watersheds, but could make rapid incursions if conditions were right, and if a source of colonization is connected. We know that most stock ponds and reservoirs in this part of the state have been stocked with introduced species of fish at some time (Steve Carson, MT FWP pers. comm. 2006). In addition to reducing native fish numbers through competition, stocked fish can often overwhelm a stream reach and displace the native species. Since these non-native or stocked fish now represent self-sustaining communities, they have considerable influence on the stream ecosystem (Scott and Helfman 2002).

Biointegrity-Threat Relationships

To analyze watershed biointegrity relationships with threats (% agriculture, % riparian grazing, roads within 40m of the stream, # of road intersections, # of gas and oil wells, dams and diversions), we used Pearson correlation coefficient (r) run in SPSS (1999, Statistical Package Software for Windows). We set the p-value of significance at $\alpha = 0.05$, but also ran these correlations with the p-value of $\alpha = 0.01$, to delineate the more robust relationships.

Future Threats

All threats have a temporal dimension. A threat may have occurred in the near or distant past, it may be ongoing, it may continue to occur, or it may begin to occur in the future. In the context of an ecoregional threat assessment, a future threat is any threat that is likely to begin or continue in the future, or is likely to intensify in scope and/or severity within a target occurrence. Distinguishing between currently occurring threats and threats that are likely to occur in the future is an important factor in considering conservation priorities and measures. Conservation plans that do not adequately consider future threats cannot fully plan for the persistence of biodiversity with any degree of confidence (Rouget et al., 2003). Therefore, the guidelines for conducting ecoregional assessments (TNC 2005), as well as the ecoregional status measures, recommend measuring the status of both current and future threats. A current threat is any threat that is currently present within a viable target occurrence, but has not yet resulted in the transformation of the occurrence from viable to non-viable. An assessment of current threats is very closely related to an assessment of the current condition of a target.

Some potential threats are real but unpredictable as to their effects (current coalbed natural gas (CBNG) research has been inconclusive to aquatic life effects so far), and therefore beyond the scope of this analysis. For example, the Powder River Basin (*see Critical Portfolio sites*) in Wyoming is currently undergoing one of the world's largest CBNG developments with ~12,000 wells in place in 2003, 14,200 in 2005, and up to 70,000 projected over the next 20 to 30 years (Davis and Bramblett, 2006). CBNG mining has the potential to severely disrupt the ecosystem and harm its biota, both in the riparian zone and within the stream itself. The interconnectedness of rivers with their watershed renders any lotic ecosystem vulnerable to threats from human activities anywhere in the landscape (Allan et al. 1997). Other areas in the portfolio sites could potentially fall victim to this pace of oil and gas development if sufficient gas reserves were found, or if the continuing upward push on natural gas prices makes the development of marginal reserves economically. Potential watersheds subject to increased oil and gas threats include the Whitewater (Northern Glaciated) (Figure 4), Rosebud and Wolf Mountains (Northwestern Great Plains).

Aggregating Threats

Overall threat status for each 5th code HUC was calculated using a simple additive method (i.e., all threat codes summed for each HUC), and the synergistic approach which allows

previously known aquatic community threats to be compounded as to their severity. In the latter approach, we considered dams and northern pike to be the most detrimental threat to aquatic diversity. Thus HUCs with moderate to severe threat levels of either were compounded by a factor of 2 to determine their new status among the other watersheds. For the most part, watersheds that ranked low in threat needed to have less than a 10 score on the additive threat and less than 5 on the synergistic threat score. Additive threats increased to moderate at 10-15, high threat status at 16-20 and severe threat status at >20 (Appendix E).

Measuring Conservation Management

The protection of natural landscapes from conversion to an unnatural state is one of the most powerful approaches to preserving biodiversity in perpetuity. Conservationists, however, widely acknowledge that land protection alone is insufficient to ensure the effective, long-term preservation of biodiversity (IUCN, 2006). To measure the potential management effectiveness of conserved areas in Montana, this project utilized an assumptions-based method based on the GAP 1-4 level analysis (Table 4), where it is assumed that a particular GAP status will yield the predicted management effectiveness across the landscape. The MT NRIS stewardship data layer was coded in a GIS to the appropriate GAP level across the NGPS ecoregion of Montana, TNC portfolio sites, and 5th code watersheds having at least 25% of their area in the portfolio sites. The framework proposed in Table 4 was the foundation for this assessment.

Therefore, we assigned each 5th code HUC within the larger portfolio sites an effectively managed conservation rating (low-0, moderate-1, high-2) based on the percentage of the HUC in GAP 1+2

Table 4. Gap Levels applied to stewardship lands within the MT NGPS Portfolio Sites

GAP Status	GAP Status Description	Permanency	Mgt. Plan	Selected Examples	Conditions for Effective Management of Biodiversity - Assumed Status
1	Areas having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a natural state within which disturbance events are allowed to proceed without interference or are mimicked through management	X	X	• Research Natural Areas (RNA) • Some TNC preserves where TNC controls management (e.g., Matador Ranch)	• Legal = VH • Resources = H • Monitoring = M • Utilization = VH • Management = H • **OVERALL = Very High/High**
2	Areas having permanent protection from conversion of natural land cover and a management plan in operation to maintain a primarily natural state, but which may receive uses or management practices that degrade the quality of existing natural communities, including suppression of natural disturbance.	X	X	• Wilderness Study Areas • Areas of Critical Environmental Concern (ACEC), Bitter Creek • U.S.F.S.Special Interest Areas • TNC conservation easements • U.S. Fish and Wildlife Service (CMR refuge)	• Legal = H • Resources = H • Monitoring = M • Utilization = H • Management = H • **OVERALL = High**
3	Areas having permanent protection from conversion of natural land cover for the majority of the area, but subject to extractive uses of either a broad, low-intensity type (e.g., logging, grazing) or localized intense type (e.g., mining, oil & gas wells).	X	-	• BLM lands • U.S. Forest Service • National Recreation Areas • State Parks • City/County Open Space and Natural Areas • State Land School Trust lands	• Legal = M • Resources =H • Monitoring = M • Utilization = H/M • Management = H/M • **OVERALL = Moderate**
4	Areas with no known public or private institutional mandates or legally recognized easements or deed restrictions held by the managing entity to prevent conversion of natural habitat types to anthropogenic habitat types. Includes all areas not identified above in categories 1-3.	short term	-	• Conservation Reserve Program (CRP) lands • Privately-owned ranches. • Cropland • Urban areas • Mines	• Legal = L • Resources = M • Monitoring = L • Utilization = M • Management = M • **OVERALL = Low**

land stewardship. A 5th code HUC with <25% of its area in GAP 1+2 received a 0 due to lack of an effective management plan; HUCs with 25-60% of the watershed area under this stewardship were assigned 1 for moderate conservation management, and finally HUCs with >60% of their land area under GAP1+2 stewardship received a 2. Permanently secured lands used these same percentage criteria, except including GAP 3 status or GAP 1+2+3 (Appendix F).

Measuring Effective Conservation

"Effective conservation" is defined as places where species, natural communities and ecological systems are viable, threats are adequately abated or minimal, and the conservation status is sufficient to enable long-term persistence of biodiversity (TNC Measures Group 2006). Effective conservation can be reported both by area (e.g., ten percent of the area within each ecoregion is effectively conserved), and by biodiversity (e.g., ten percent of the biodiversity within each ecoregion will be effectively conserved). To be consistent TNC will strive to measure progress toward achieving effective conservation of biodiversity rather than area. In the context of ecoregional measures and the 2015 goal, 'effective conservation' is the degree to which target occurrences within ecoregions meet their numeric and distribution goals towards conserving 10% of all biodiversity. Thresholds on "effectively conserved" status have not been set, and probably are still determined by best professional judgment on an individual site or project basis. As an unbiased calculation using a three-tier system, the Effective Conservation Index threshold as an average of the 3 appears to be 1.67, while averages of 1.33 offer good opportunities to upgrade status to EC (Table 5).

Table 5. Calculation of Effective Conservation Index (EC) w/ the intersection strategy. Conservation status: NE= not conserved, EC= effectively conserved, =not considered

Target Viability[1]	Threats[2]	Protection Status[3]	EC Index	Conservation Status	Good Opportunity	Challenges
0	0	0	0.00	NE		
1	0	0	0.33	NE		
2	0	0	0.67	NE		?
0	1	0	0.33	NE		
1	1	0	0.67	NE		
2	1	0	1.00	NE		?
0	2	0	0.67	NE		
1	2	0	1.00	NE		?
2	2	0	1.33	NE	X	
0	0	1	0.33	NE		
1	0	1	0.67	NE		
2	0	1	1.00	NE		?
0	1	1	0.67	NE		
1	1	1	1.00	NE		?
2	1	1	1.33	NE	X	
0	2	1	1.00	NE		?
1	2	1	1.33	NE	X	
2	2	1	1.67	NE	X	
0	0	2	0.67	NE		?
1	0	2	1.00	NE		?
2	0	2	1.33	NE	X	
0	1	2	1.00	NE		?
1	1	2	1.33	NE	X	
2	**1**	**2**	**1.67**	**EC**		
0	2	2	1.33	NE	X	
1	**2**	**2**	**1.67**	**EC**		
2	**2**	**2**	**2.00**	**EC**		

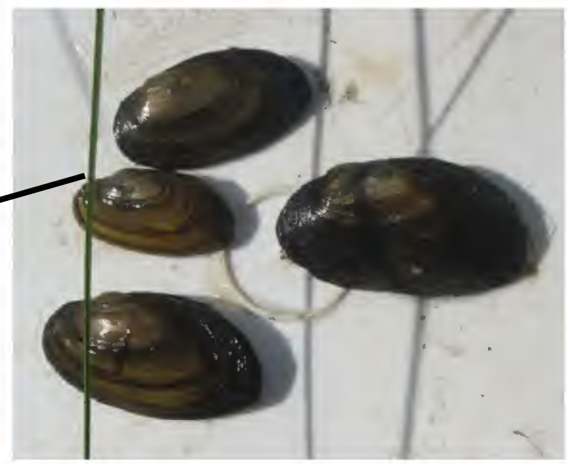
[1]Target Viability: 0= poor/low viability, 1= fair viablity, 2= good to excellent viability

[2]Threats: 0= high threats, 1=moderate, 2=zero to low threats

[3]Conservation Management: 0= no protection, 1= fair, 2=good protection/management

In the simplest terms "effective conservation" is not attained at sites that are not viable, highly threatened, and not protected, or most combinations of fairly viable with any threats and little protection. However, aquatic sites with fair viability that were included into a portfolio site based on terrestrial features, and now have effective management and abated threats offer good opportunities for restoration leading to effective conservation (see Text Box). The best opportunity to change conservation status is aquatic targets exhibiting high viability, experiencing low threats, but with little management protection. Strengthening or initiating conservation management in these situations is a quick response action to achieving EC. Hence, although these sites may be currently experiencing low threats, how long will this situation remain? *See **Powder River** in Critical Sites section.* Challenging situations to achieving target status as "Under Effective Conservation" are low to fair viability status with low threats and minimal management or good viability with high threats and low to moderate management in place. The action for these situations would be to strengthen or start effective management practices and begin to abate threats.

Project Restoration Potential: Aquatic Targets that have fair viability or are threatened by moderate, but low intensity threats (i.e., cattle grazing), but are protected in either case should be considered for restoration projects. The Matador Ranch in the Northwestern Glaciated Plains is a good example of this potential. Fair aquatic viability and moderate threats before TNC conservation action (acquired as a TNC preserve in 2000) are currently evolving to low threat, moderate aquatic viability under proper conservation management. One stream reach example is pictured: Gravel substrate is returning to a previously silted stream reach, with Pyganodon grandis mussels (pictured), and four of six expected native fish species present.



Results

The TNC NGPS Portfolio Sites in Montana encompass viable occurrences of all 15 types of prairie aquatic ecological systems (eight biological) including multiple occurrences of high ecological integrity fish and macroinvertebrate communities with their associated SOC species (Tables 6, 7& 8; Figure 8), yet only 20% of these aquatic ecological systems have occurrences that are "effectively conserved."

Status of Aquatic Biodiversity

Overall, 34 of Montana's 43 native fish species reside within the prairie ecoregion. Nine of these species are MT Species of Special Concern (SOC), one of which is listed as Endangered by the USFWS* and four that are potential species of concern (PSOC) (MTNHP 2006). During the initial phase of the NGPS Conservation Plan, only four of these SOC species were identified as Primary Conservation Targets with five other fish species as secondary targets. Unfortunately, the four primary fish species targets inhabit only two of the eight aquatic ecological systems which represent the whole of lotic aquatic diversity within the ecoregion (Table1). Despite this, the revised original portfolio sites contain stream reaches with occurrences of 33 native species or 97% of the possible fish fauna encountered for MT's NGPS ecoregion. The only fish species not having at least one occurrence in the portfolio is the shortnose gar. This species is only known from two sites below Fort Peck Dam which would be considered unviable in terms of conservation.

Fine-scale aquatic targets were adequately represented in the revised portfolio sites across all taxonomic groups (Appendix A). Fish and aquatic invertebrate SOC were significantly covered by the portfolio sites with average percent occurrences of 66% and 77%, respectively (Table 6). The only targeted fish species of concern not effectively included in the portfolio is the pearl dace, with only one record (Table 6), and most of the viable populations are located in the Big Muddy Creek Watershed (Figure 8).

*United States Fish and Wildlife Service Status on the Endangered Species List: LT=Listed Threatened, LE=Listed Endangered, C=Candidate species for listing

Table 6. Aquatic MT SOC target occurrences (EOs), conservation status (Global_Rank, State_Rank), and % of all EO occurrences in MT found in the portfolio sites. na= not available.

Scientific Name	Common Name	G-Rank	S Rank	Taxonomic Group	# Target EOs in the Portfolio Sites	% all EOs in the Portfolio Sites
Chelydra serpentina	Snapping Turtle	G5	S3	reptiles	2	na
Apalone spinifera	Spiny Softshell	G5	S3	reptiles	12	60%
Anepeorus rusticus	Mayfly	G1	S1	invertebrates	2	100%
Macdunnoa nipawinia	Mayfly	G1G3	S2	invertebrates	4	75%
Homoeoneuria alleni	Mayfly	G4	S2	invertebrates	6	100%
Raptoheptagenia cruentata	Mayfly	G4	S2	invertebrates	10	60%
Lachlania saskatchewanensis	Mayfly	G4	S1	invertebrates	4	50%
						77%
Scaphirhynchus albus	Pallid Sturgeon	G1G2	S1	fishes	5	100%
Macrhybopsis meeki	Sicklefin Chub	G3	S1	fishes	4	100%
Macrhybopsis gelida	Sturgeon Chub	G3	S2	fishes	11	92%
Cycleptus elongatus	Blue Sucker	G3G4	S2S3	fishes	5	50%
Polyodon spathula	Paddlefish	G4	S1S2	fishes	8	100%
Phoxinus eos x P. neogaeus	Hybrid Dace	G5	S3	fishes	1	14%
Margariscus margarita	Pearl Dace	G5	S2	fishes	1	5%
						66%

Table 7. Aquatic non-SOC secondary target occurrences (EOs), conservation status (Global_Rank, State_Rank), and % of all EO occurrences in MT found in the portfolio sites. na= not available.

Scientific Name	Common Name	G-Rank	S Rank	Taxonomic Group	# Target EOs in the Portfolio Sites	% all EOs in the Portfolio Sites
Hybognathus hankinsoni	Brassy Minnow	G5	SU	fishes	18	na
Hybognathus placitus	Plains Minnow	G5	SU	fishes	22	na
Phoxinus eos	Northern Redbelly Dace	G5	SU	fishes	9	20%
Semotilus atromaculatus	Creek Chub	G5	SU	fishes	16	25%
Noturus flavus	Stonecat	G5	S3	fishes	16	na
Culaea inconstans	Brook Stickleback	G5	SU	fishes	33	na
Etheostoma exile	Iowa Darter	G5	SU	fishes	9	na
						na
Analetris eximia	Sand mayfly	G2G4	S3	invertebrates	6	67%
Ametropus neavei	Mayfly	G4	S3	invertebrates	8	75%
Stylurus intricatus	Brimstone Clubtail	G4	SU	Dragonflies	5	100%
Arigomphus cornutus	Horned Clubtail	G4	S2S4	Dragonflies	2	100%
Gomphus externus	Plains Clubtail	G5	S2S4	Dragonflies	5	60%
Macromia illinoiensis	Illinois River Cruiser	G4	SU	Dragonflies	1	100%
						84%

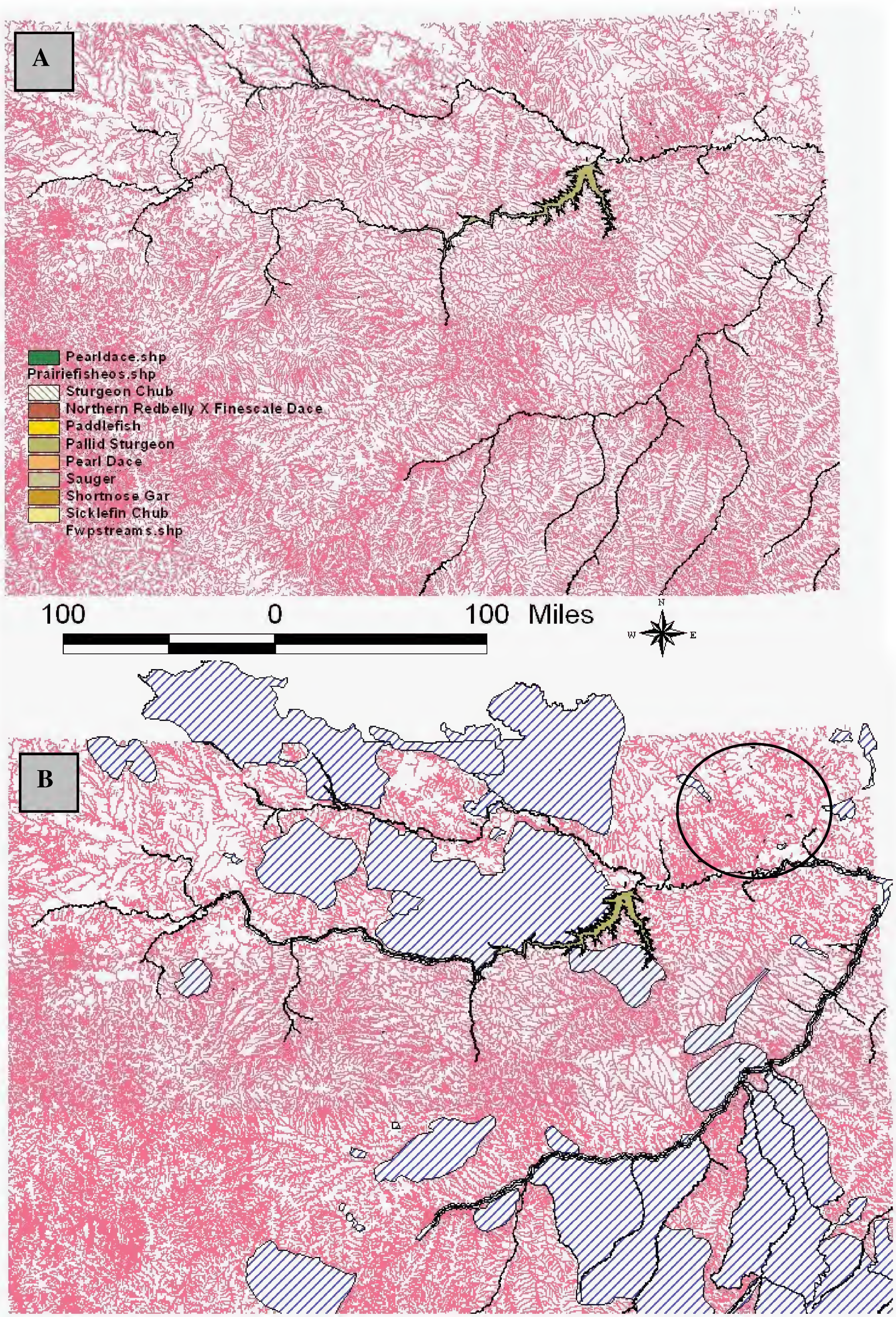


Figure 8. Fish SOC stream reaches (black) in the NGPS region of MT (A) and Portfolio Sites overlay on the fish EO stream reaches (B). Circled area represents the pearl dace critical area

Status of Aquatic Ecological Systems

The TNC portfolio sites of Montana encompass ~30% of the river miles of all ecological systems within the NGPS ecoregion (Table 8). Over 65% of the watersheds within the portfolio have good to excellent community biointegrity (Figure 9). The Large River AES is highly represented in the portfolio by having almost 50% of total available miles in the state included. The percentage of the Large River and Northwestern Great Plains Prairie Stream targets included in the portfolio with good to excellent viability is also very high (Table 8). A large percentage of watersheds within the portfolio sites (50 of 68 fifth-code HUCs) exhibit good to excellent aquatic community biointegrity (i.e., viability) using the slightly different color scheme on the left (Figure 10).

The two reasons that caused most watersheds to rank within the fair to poor integrity category were introduced fish species (e.g. lowering the IBI or O/E scores) and poor macroinvertebrate MMI scores, indicating some sort of habitat or water quality impairment.

Table 8. Aquatic Ecological System occurrences by river mile in MT and the portfolio sites

NGPS AES River Type	Total AES River Miles in NGPS of MT	River miles in MT NGPS Portfolio sites	% of AES types by river mile in Portfolio	% of AES in Portfolio w/ A + B viability
Large Valley River	1,277.8	584.9	**45.8**	**81.0**
Large Prairie River	1,385.1	530.6	**38.3**	**61.0**
Medium Prairie River	1,559.3	461.2	**29.6**	**59.3**
Northern Glaciated Prairie Stream	1,507.3	484.9	**32.2**	**66.3**
Northwestern Great Plains Prairie Stream	3,163.6	695.2	**22.0**	**74.1**
Northern Glaciated Intermittent Prairie Stream	25,494.9	6,347.8	**24.9**	**50***
Northwestern Great Plains Intermittent Prairie	57,799.9	19,130.9	**33.1**	**50***
Northwestern Great Plains Perennial Spring	20*	~5.0*	**~25***	**3.8***
Sum Total	**95,122.2**	**28,886.4**	**30.0**	**55.7**

*not calculated, estimated

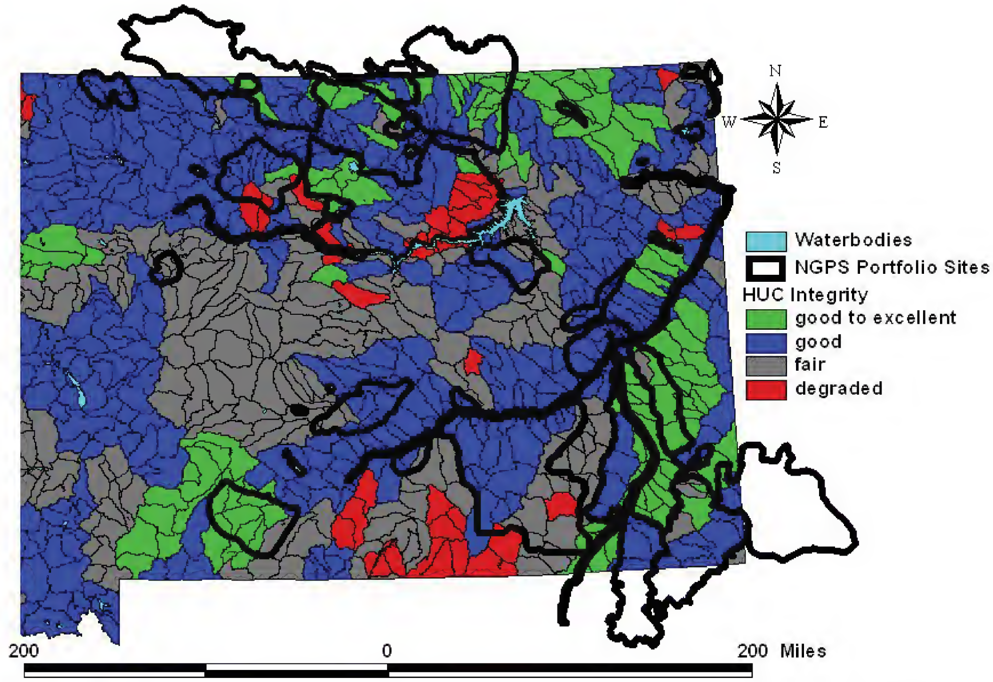


Figure 9. Aquatic community integrity of all watersheds within MT TNC Portfolio Sites

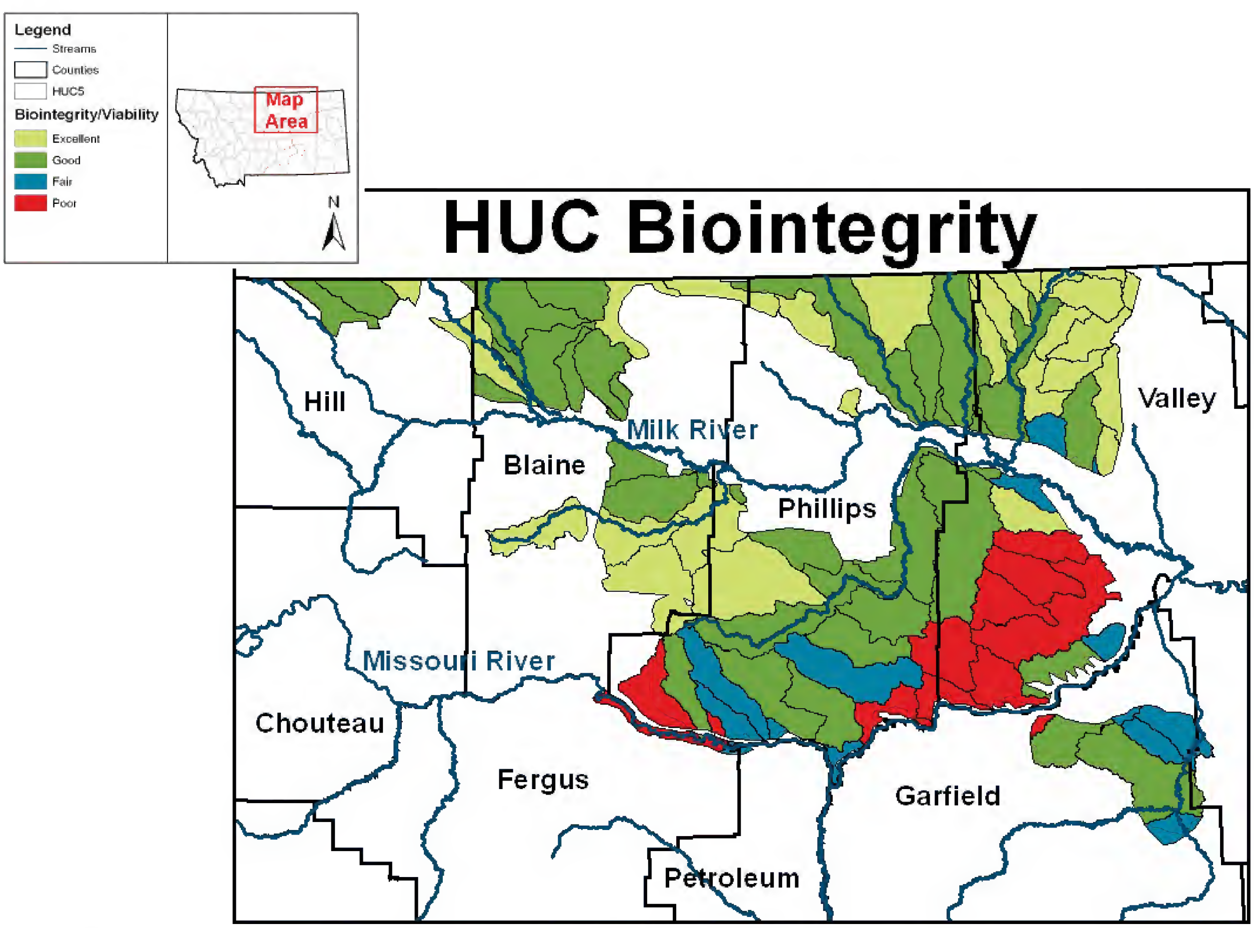


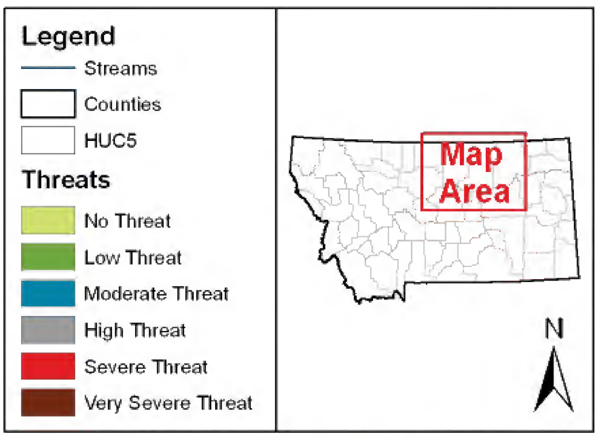
Figure 10. Aquatic community integrity of the selected MT TNC Portfolio Sites

Status of Threats

The next series of threats maps are based on the following legend, where the threat-rank coding is based on criteria outlined in the methods section. Although the 5th code HUCs are clipped to the portfolio shape, the entire HUC was analyzed for any individual threat assessment (accept those extending into Canada). The results of threat analysis for the portfolio sites reveal that percent agriculture and surface diversions in the watersheds contributed some of the broadest landscape threats both in scope and severity (Figure 11). While riparian grazing is widespread in scope, it is less severe in intensity. Only 8 of the 68 watersheds evaluated were free of dams, and the average number of dams per 5th code HUC was five.

The number of oil and gas wells and the metrics dealing with road density and road crossings within the HUC are more regionalized, but locally severe (Figure 12). The presence and abundance of northern pike is an underlying broad scope and moderately high intensity threat across many 5th code watersheds in the study area. We have already mentioned that the presence of pike and other introduced fish species has already reduced the viability of some other watershed integrity measures (see Status of Biodiversity section).

Overall threat status using the additive method indicated that nearly ~50% of 5th code HUCs exhibited high to severe threats to biodiversity; while the synergistic threats assessment revealed slightly more than 65% of the HUCs exhibited low to moderate threats to biodiversity (Figure 13).



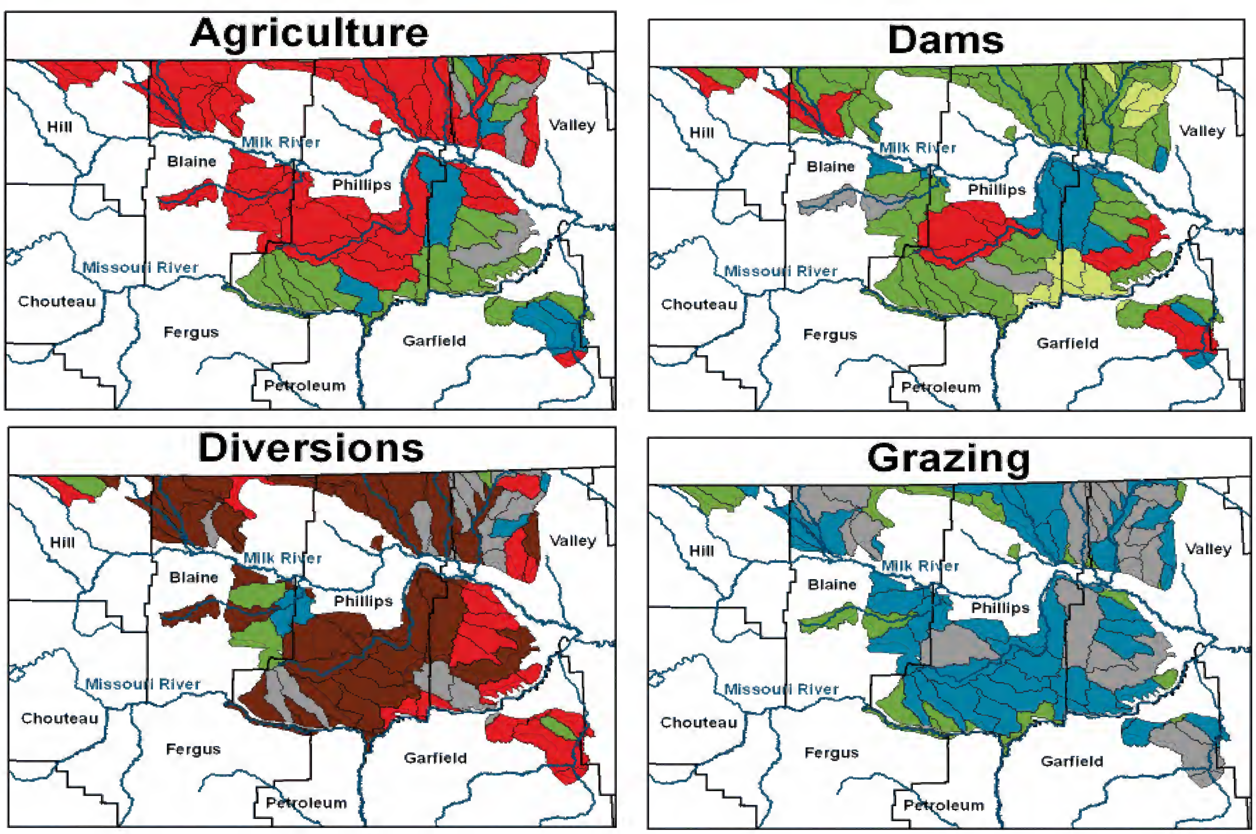


Figure 11. Threats by watershed within the selected TNC Portfolio Sites

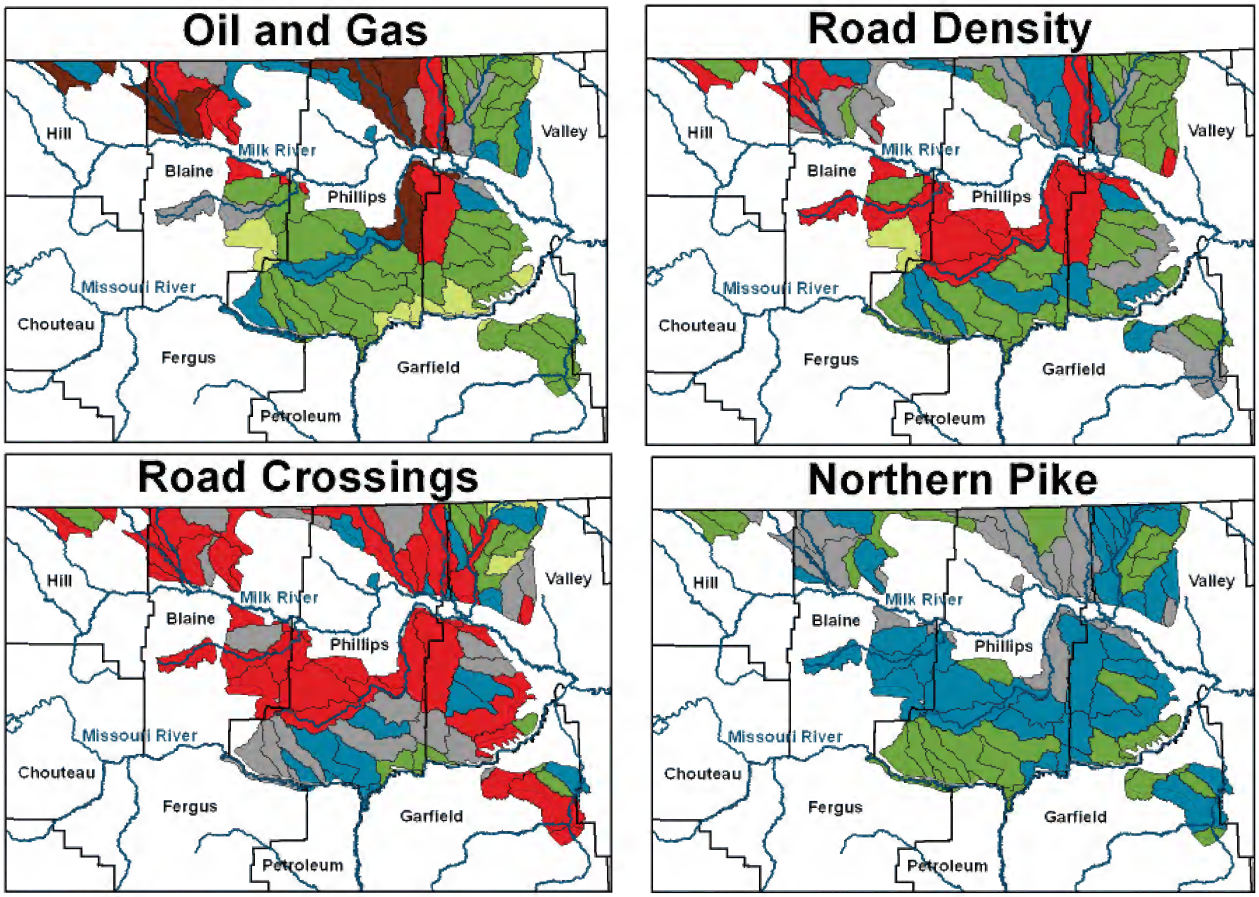


Figure 12. Additional threats by watershed within the selected TNC Portfolio Sites

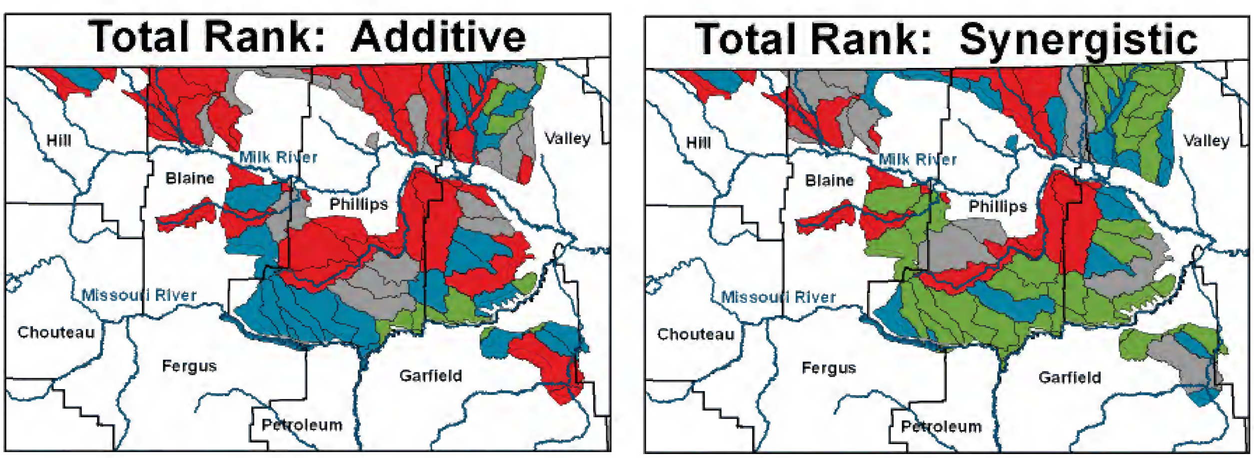


Figure 13. Additive and Synergistic threats by watershed within the selected Portfolio Sites

Biointegrity-Threat Relationships

No significant negative relationships were indicated with HUC biointegrity and percent riparian grazing, roads within 40m of the stream, # of road intersections, # of gas and oil wells, dams or surface diversions, except there was a slight positive correlation with % agriculture in the 5th code HUC (r = 0.32, p<0.05) (Table 6). HUC biointegrity ranking was positively correlated to % GAP 4 land management (r = 0.44, p<0.01) and negatively correlated with % managed lands in GAP 2, 1+2, or 1+2+3 (r = -0.50, -0.49, -0.44 p<0.01), respectively. At the landscape view, private lands appear to be more effectively managed for watershed integrity than publicly-owned and even conservation managed areas. Four of the aforementioned factors (% ag, roads, dams and diversions, and oil and gas wells) were positively correlated with the size of the 5th Code HUC, and % of the HUC in GAP 4 land management (r =0.56, 0.56, 0.75, p<0.01), while negatively correlated with % of HUC in GAP 1+2+3 (r = -0.56, -0.56, -0.75, p<0.01) (Table 6). The other significant associations are quite intuitive given the landscape in this ecoregion; road density is positively linked with increased numbers of dams, diversions, and oil and gas wells. Road crossings and numbers of dams are positively associated, as are surface diversions and oil and gas wells (r=0.65, p<0.01) (Table 6). We did not find clear relationships between the broad-scale and fine-scale assessments. Landscape scale assessments look at impacts (i.e. the activities that change natural conditions), while fine-scale assessments examine the results of those impacts (Vance 2005). Theoretically, HUC biointegrity should be highest with fewer impacts, but this was not exhibited in the analysis. Impacts may occur at a significance distance from their effects. Localized impacts and reach-scale communities may also override watershed-level ones.

Table 9. Pearson's correlation coefficient (r) table of threats, effective management and HUC viability. Significant correlations at the α <0.05 level are bolded. Significant correlations at the α <0.01 level are bolded, red and underlined. Parameter abbreviations are explained in the methods section and Table 3

	%HUC_in PO	Rip_ Graz	P_Ag_ Site	StreamMile 40mRd	Interxn Roads & Streams	Count of Dams	Count of Oil & Gas Wells	Count of Surface Diversions	% in GAP 1	% in GAP 2	% in GAP 3	% in GAP 4	% in GAP 1+2	% in GAP 1+2+3	HUC_Bio Rating
Acres HUC	**-0.32**	**0.74**	0.14	**0.65**	**0.71**	**0.45**	**0.33**	**0.55**	0.18	0.05	**-0.32**	0.19	0.07	-0.19	-0.08
% HUC in PO	1.00	0.11	**-0.53**	-0.21	-0.21	0.01	-0.03	-0.11	0.13	-0.19	**0.49**	-0.25	-0.17	0.25	0.06
Rip Graz		1.00	-0.15	**0.55**	**0.64**	**0.53**	0.18	0.28	0.19	-0.13	-0.04	0.07	-0.10	-0.07	-0.04
% Ag Site			1.00	**0.38**	**0.39**	0.11	**0.30**	0.20	-0.14	**-0.44**	**-0.60**	**0.75**	**-0.45**	**-0.75**	**0.32**
40m Rd				1.00	**0.96**	**0.48**	**0.30**	0.21	0.09	**-0.34**	**-0.48**	**0.56**	**-0.33**	**-0.56**	0.14
Intersect_Roads & Streams					1.00	**0.54**	**0.34**	0.26	0.05	**-0.35**	**-0.47**	**0.56**	**-0.34**	**-0.56**	0.10
Count of Dams						1.00	0.11	0.16	0.30	-0.20	-0.17	0.20	-0.17	-0.20	-0.05
Count of Oil & Gas Wells							1.00	**0.65**	-0.08	-0.19	-0.12	0.20	-0.20	-0.20	0.09
Diversions								1.00	0.09	-0.16	-0.05	0.09	-0.15	-0.09	0.14
% in GAP 1									1.00	0.05	0.00	-0.09	0.17	0.09	0.00
% in GAP 2										1.00	0.03	**-0.56**	**0.99**	**0.56**	**-0.50**
% in GAP 3											1.00	**-0.80**	0.03	**0.80**	-0.13
% in GAP 4												1.00	**-0.56**	**-1.00**	**0.44**
% in GAP 1+2													1.00	**0.56**	**-0.49**
% in GAP 1+2+3														1.00	**-0.44**

Status of Conservation Management

Conservation management status across the NGPS ecoregion in MT is largely in tracts of private, unprotected lands (Gap 4); permanently protected and biodiversity-managed lands (Gap 1+2) make up less than 10% (5.9% average) by area of any subsection of the ecoregion, and permanently secured public lands, but open to extractive activities (Gap 3) average ~20% across all areas of the NGPS ecoregion (Table 10, Figure 14).

Within the evaluated TNC portfolio sites the status of conservation management shifts to large tracts of Gap 3 lands (~50%), mostly BLM managed, and a higher percentage of GAP 1+2 protected lands (Table 11). Montana Glaciated Plains and Hell Creek Badlands portfolio sites contain the highest percentage of GAP 1+2 protected lands, 17.2 and 11.6, respectively.

Only 9 of the 68 fifth-code HUC watersheds that we evaluated meet the criteria of effectively managed lands, and 8 more are moderately managed (Figure 15, Appendix F). If we loosen the criteria to include permanently secured lands (GAP 1+2+3), than the number of 5th code watersheds under this lesser ranking of highly to moderately secured increases to 48 of 68 (71%) of the watersheds (Figure 15, Appendix F).

Unfortunately the percentage of "effectively managed" lands within any given watershed was not indicative of high biointegrity (e.g., viability) of the aquatic ecosystem. In fact, there is a significantly negative relationship with % GAP 2 and 1+2 lands and the biointegrity of the aquatic communities, $r = -0.5$ and -0.49 ($p<0.01$), respectively (Table 9). HUC biointegrity ranking was positively correlated % GAP 4 land management ($r = 0.44$, $p<0.01$). So, although there may be uncertainty in the protected status

Table 10. Gap coverage by subsections of the NGPS ecoregion in MT

Sub_Ecoregions	% GAP 1	% GAP 2	% GAP 3	% GAP 4
Rocky Mountain Front Foothills	0.8	9.7	20.0	69.5
Northwestern Glaciated Plains	0.3	2.4	18.1	79.3
Northwestern Great Plains	0.0	5.6	21.3	73.1
Average	**0.3**	**5.9**	**19.8**	**74.0**

Table 11. Gap coverage by evaluated Portfolio sites of the NGPS in MT

MT Portfolio_Site	% GAP 1	% GAP 2	% GAP 3	% GAP 4
Montana Glaciated Plains	1.8	15.4	42.7	40.1
Bitter Creek/Grasslands	0.0	9.3	54.0	36.7
Sage Creek/SW Pastures	0.0	2.5	30.3	67.2
Hell Creek Badlands	0.0	11.6	49.2	39.2
Whitewater Wetlands	0.0	1.0	65.2	33.7
Average	**0.4**	**8.0**	**48.3**	**43.4**

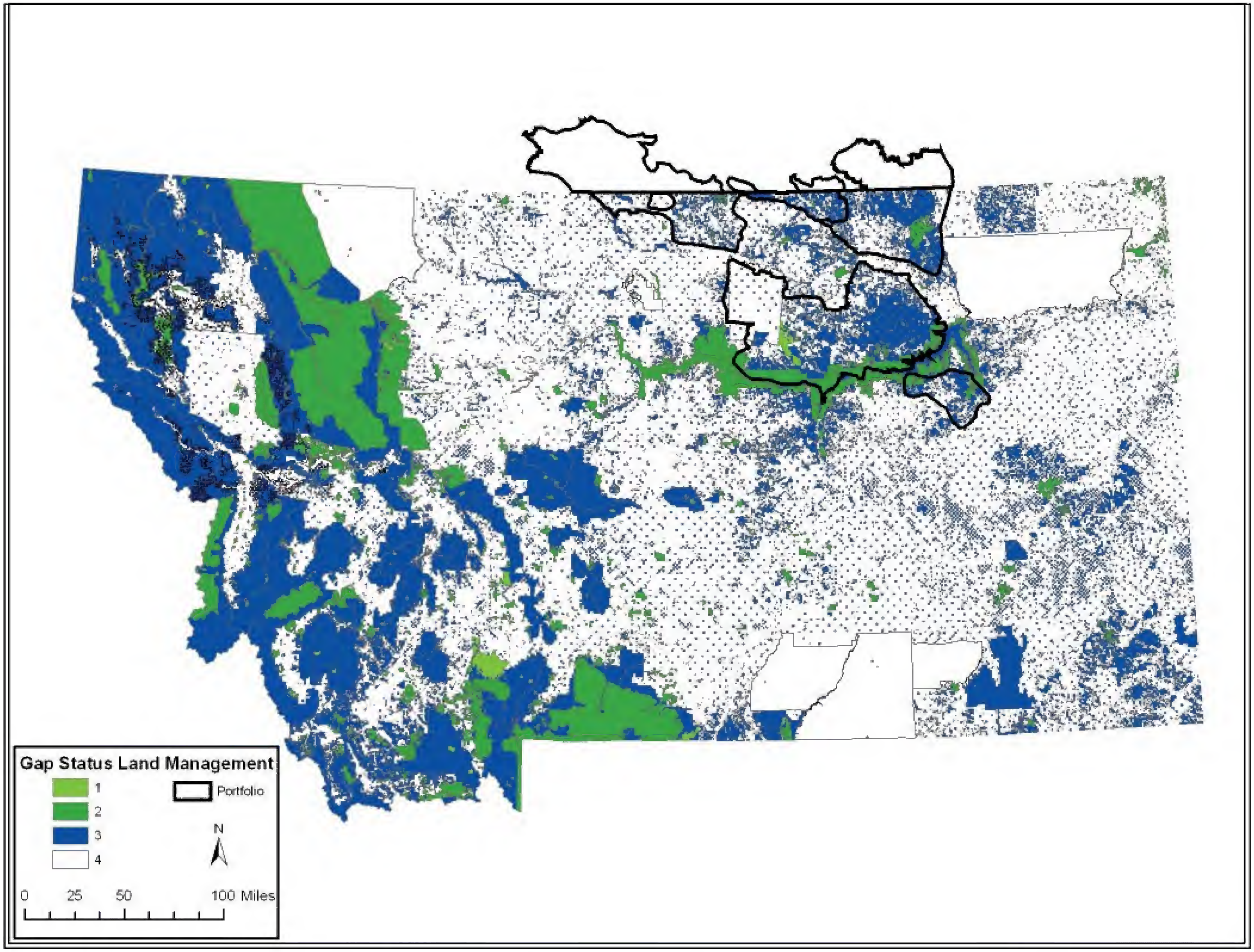
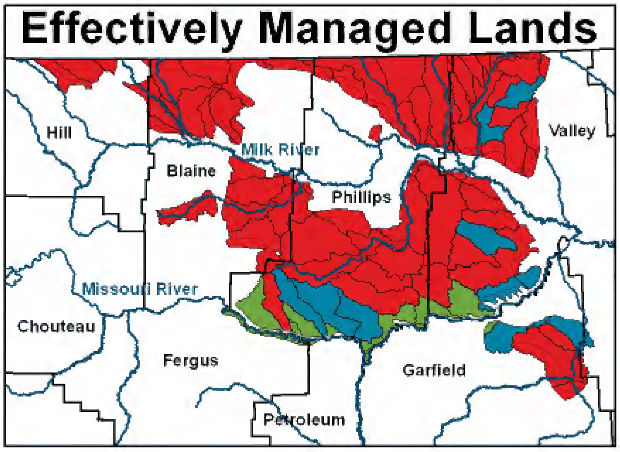


Figure 14. Statewide Coverage of GAP Status Lands. Large blocks are Bureau of Indian Affairs Lands and are coded in GAP 4



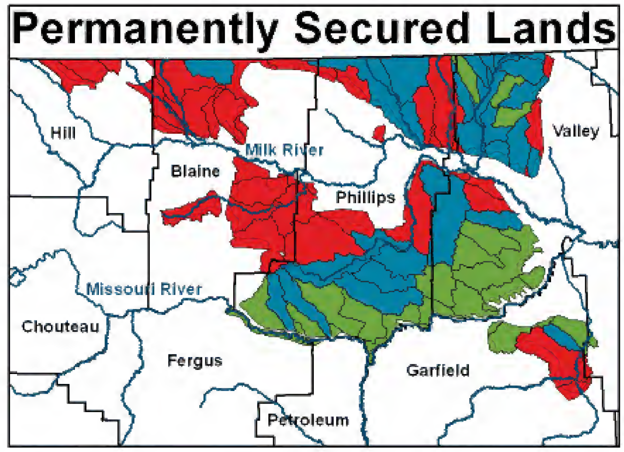


Figure 15. Percent of watershed in GAP 1+2 management status (left) and GAP 1+2+3 (right). Green, Blue and Red Shading = high, moderate & low % of watershed, respectively

of privately owned prairie lands (GAP 4), in the Northern Glaciated Plains, these harbor some of the more intact aquatic communities of the portfolio sites. Thus, the premise that GAP 1+2 lands are being effectively managed is uncertain and even misleading, unless a more thorough evaluation (beyond the scope of this project) is conducted. Although from personal on-the-ground evaluations of stream sites within areas of the C.M. Russell National Wildlife Refuge and Cow Creek ACEC (BLM National Monument) (both GAP 2 status lands within the portfolio), the "management effectiveness" of this designation has not contributed to proper management on the landscape, and has not in some cases led to intact aquatic systems.

Status of Effective Conservation

Effective conservation of aquatic systems in the NGPS portfolio sites in MT is quite low. Six of the 68 (8.9%) evaluated 5th code HUCs are effectively conserved; if summed by area; this represents only 9.7% of that portfolio area (Figure 16) and encompasses only 529 river miles. If compared to the total river miles delineated in the portfolio sites; those effectively conserved represent only 1.8% available (Figure 17). If we adjust the criteria of "effective conservation" to Permanently Secured-Low Threat Viable Watersheds without effective management than the number of 5th code HUCs increases to 24 of the 68 (35%) or 30.6% of the portfolio area.

Effective Conservation status across the selected portfolio sites within MT is largely restricted to disjunct small watersheds in the headwaters of small prairie stream AES; while watersheds supporting viable occurrences of the Northern Glaciated Perennial Streams and Medium Prairie River AES types are only attained in the Permanently Secured Management areas (Figure 16). These areas, though not "effectively conserved" contain some of the critical aquatic targets within the watershed areas and are good opportunities for action (See Critical Sites).

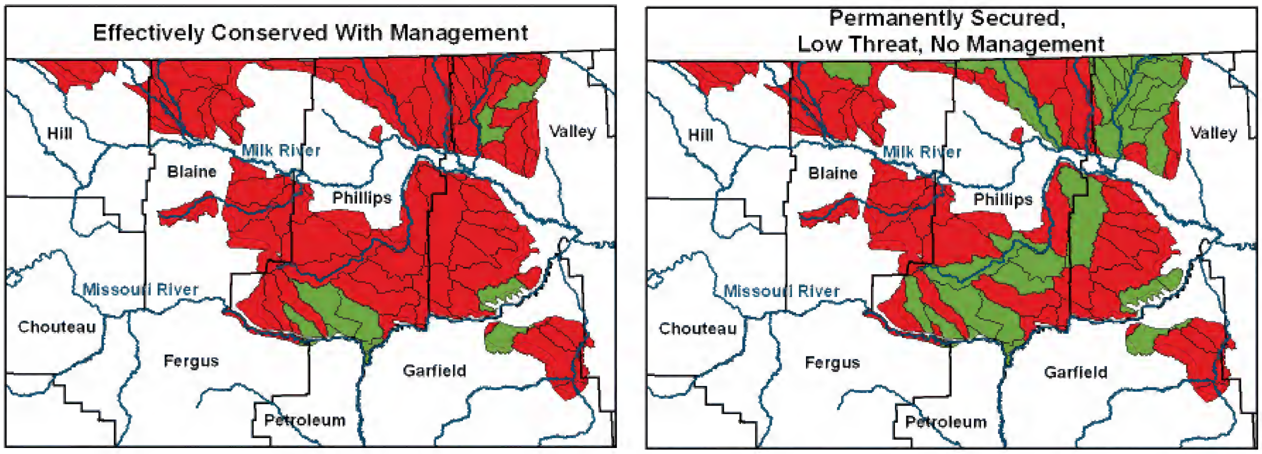


Figure 16. Watershed Diversity Effectively Conserved in green (left) and Permanently Secured-Low Threat Viable Watersheds (right)

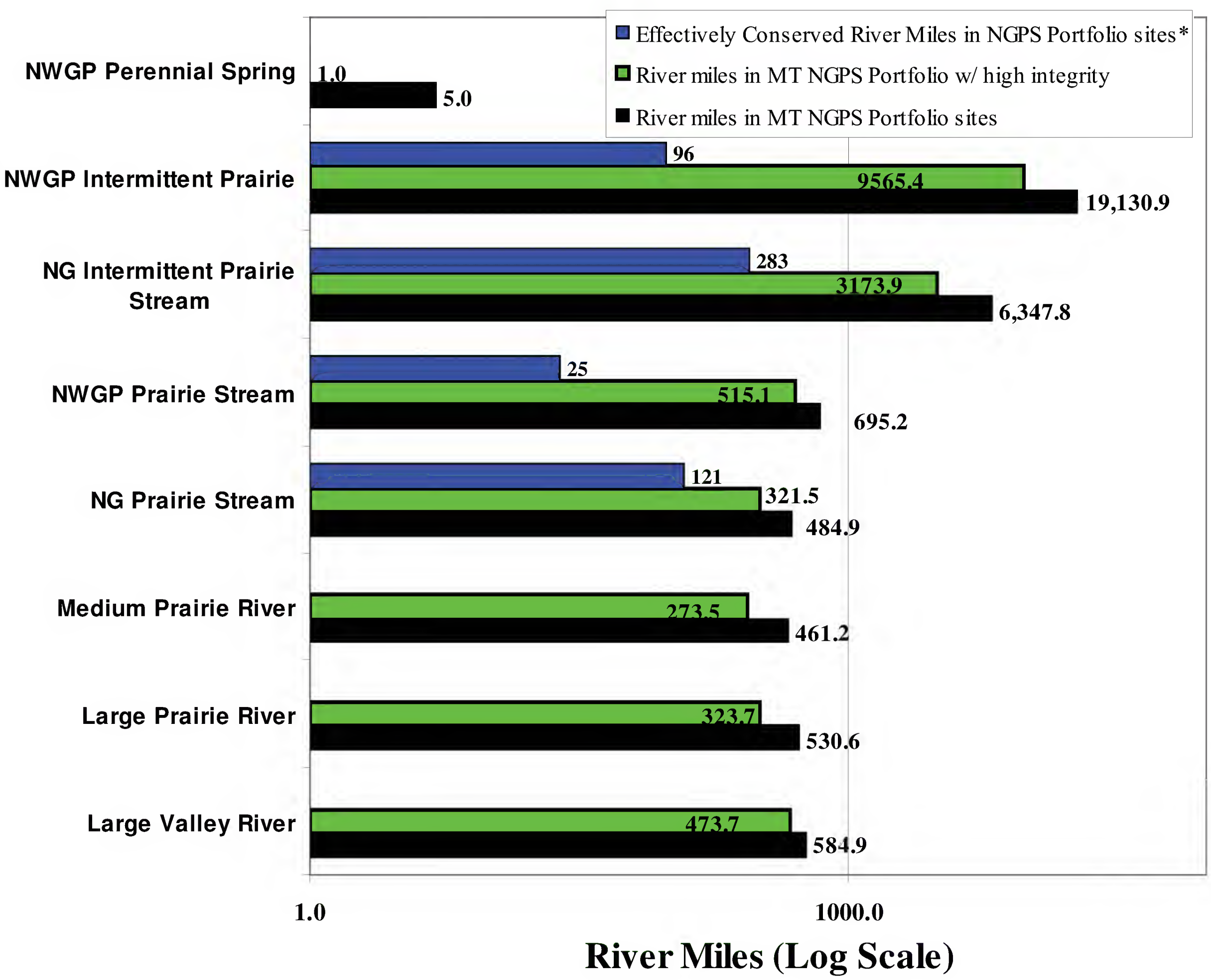


*Figure 17. River miles of High Integrity and Effective Conservation of Aquatic Ecological Systems within the *selected Portfolios sites. NG=Northwestern Glaciated, NWGP= Northwestern Great Plains*

Critical Aquatic Sites in MT NGPS Ecoregional Portfolio

<u>Portfolio Sites: Lower Yellowstone and Missouri Confluence Areas, Upper Missouri River Aquatic Ecological System: Large Valley River</u>

1) **Lower Yellowstone River -** High Biodiversity, Moderate Threats and Low Protection (EC Index = 1.0)

Figure 18. Lower Yellowstone River near Seven Sisters (left) and Diamond Willow (right) upstream of Sidney, MT showing extensive sandy-bottom habitat

2) **Lower Missouri River -** High Biodiversity, Moderate Threats and Low Protection (EC Index = 1.0)

3) **Middle Missouri River -** High Biodiversity, Low-Moderate Threats and Moderate Protection (EC Index = 1.33)

Figure 19. Missouri River in the Wild & Scenic Reach near Kipp Bridge (left) and Little Sandy (right)

Effective conservation of the Large Valley River Ecological System portfolio sites would accomplish conserving the <u>last free-flowing large river system segments</u> (Lower Yellowstone River) and "functionally" free-flowing reaches (Middle and Lower Missouri River) and their associated communities. These sites represent the some of the last fully functional reaches of large valley rivers within the NGPS, and perhaps the best examples in the Neararctic Realm. Abell et al. (2000) ranked the Upper Missouri Freshwater Aquatic Ecoregion as nationally important and vulnerable to threats,

especially the biodiversity of the large river sections. The conservation value of these segments is just being realized with the recent documentation and inclusion of 6 aquatic invertebrate species as Montana Species of Concern in 2006 (MTNHP 2006, SOC's, 2 G1-G3) with viable populations found in these large-order, sandy-bottomed river sections. Global persistence of at least 4 fish species (i.e., Pallid Sturgeon, Paddlefish, Sturgeon and Sicklefin Chubs) is dependent on sustaining viable populations in these reaches. Unfortunately, effective conservation of such large watersheds with upstream cumulative effects orders of magnitude than those seen at the 5th or even 4th code HUC levels is daunting.

Portfolio Sites: Powder River, Lower Powder River Breaks, Wolf Mountains Large Prairie River Ecological System

1) **Powder River -** High Biodiversity, Moderate Threats and Low Protection (EC Index = 1.0)

Figure 20. Powder River near Moorhead (left) and upstream of Broadus (right)

2) **Lower Tongue River -** Moderate Biodiversity, Moderate Threats and Little Protection (EC Index = 0.67)

The Powder River is a vast drainage representing one of the last undammed, large prairie river systems in the Neararctic Realm. In this part of southeastern Montana, the landscape through which the Powder flows resembles a virtually natural condition-state of a large prairie river. The Powder River aquatic ecosystem supports many target elements of community function and biological diversity associated with its physical setting, including 25 native fish species (19 in Montana; 2 SOC's) and numerous species of rare invertebrates, some of the same sand-dwelling specialists (4 SOC's) found in the lower large valley systems (MT NHP 2006, Stagliano 2006). With its specialized aquatic life, the Powder River supports not only a diverse community but represents the sole remnant of a once widespread Great Plains riverine community of fish and invertebrates (Hubert 1993). Other Large Prairie Rivers within Montana's NGPS that include occurrences of moderate viability are the Lower Bighorn, Tongue and Marias Rivers, but unlike the Powder these are disrupted and hydrologically affected by dams and reservoirs.

Portfolio Sites: Montana Glaciated Plains, Whitewater Wetlands, West Fork Popular River, Frenchman/Bitter Creek, Sage Creek/SW Pastures Aquatic Ecological System

Medium Prairie River (AES B006)

1) **Rock Creek -** High Biodiversity, Moderate Threats and Moderate Protection (EC Index = 1.33)
2) **Frenchman Creek** - High Biodiversity, Moderate Threats and Low Protection (EC Index = 1.0)
3) **Beaver Creek** - Moderate Biodiversity, Low Threats and Low Protection (EC Index = 1.0)
4) **Battle Creek** - Moderate Biodiversity, Moderate Threats and Low Protection (EC Index = 0.67)

Northwestern Glaciated Plains Prairie Stream (AES C006)

1) **Peoples Creek** - High Biodiversity, Moderate Threats and Moderate Protection (EC Index = 1.33)
2) **Clear Creek** - High Biodiversity, Moderate Threats and Moderate Protection (EC Index = 1.33)
3) **Rock Creek** - High Biodiversity, Moderate Threats and Moderate Protection (EC Index = 1.33)
4) **Big Warm & Little Warm Creek** - Moderate Biodiversity, Low Threats and Moderate Protection (EC Index = 1.0)
5) **Beaver Creek** - Moderate Biodiversity, Low Threats and Low Protection (EC Index = 1.0)
6) **Whitewater** - Moderate Biodiversity, Moderate Threats and Low Protection (EC Index = 0.67)
7) **Battle Creek** - Mod. Biodiversity, Moderate Threats and Low Protection (EC Index = 0.67)

Northern Glaciated Plains Prairie Stream (AES C008)

1) **West Fork Poplar River** - Moderate Biodiversity, Low Threats and Moderate Protection (EC Index = 1.0)
2) **Tule Creek** - Moderate Biodiversity, Moderate Threats and Moderate Protection (EC Index = 1.0)

Northern Glaciated Plains Intermittent Stream (AES D006, D008)

1) **Bitter Creek** - High Biodiversity, Moderate Threats and Moderate Protection (EC Index = 1.33)
2) **Willow Creek** - High Biodiversity, Moderate Threats and Moderate Protection (EC Index = 1.33)
3) **Snake Creek** - Moderate Biodiversity, Low Threats and Moderate Protection (EC Index = 1.33)
4) **Buggy Creek** - Moderate Biodiversity, Low Threats and Moderate Protection (EC Index = 1.33)
5) **CK Creek** - Moderate Biodiversity, Moderate Threats and Moderate Protection (EC Index=1.0)
6) **Spiryann Creek** - Moderate Biodiversity, Low Threats and Low Protection (EC Index = 1.0)
7) **East Fork Battle Creek** - Moderate Biodiversity, Moderate Threats and Low Protection (EC Index = 0.67)

Portfolio Sites: Powder River, O'Fallon Creek Badlands, Little Missouri River Headwaters & Plains, Hell Creek & Terry Badlands, Wolf Mtns/N. Cheyenne

Medium Prairie River (AES B005)

1) **Little Missouri River** - High Biodiversity, Moderate Threats and Low Protection (EC Index=1.0)
2) **Little Powder River** - High Biodiversity, Moderate Threats and Low Protection (EC Index = 1.0)

Northwestern Great Plains Prairie Stream (AES C005)

1) **O'Fallon Creek** - High Biodiversity, Moderate Threats and Low Protection (EC Index = 1.0)
2) **Box Elder Creek** - High Biodiversity, Moderate Threats and Low Protection (EC Index = 1.0)
3) **Rosebud Creek** - Moderate Biodiversity, Moderate Threats and Moderate Protection (EC Index = 1.0)

4) **Pumpkin Creek** - High Biodiversity, Moderate Threats and Low Protection (EC Index = 1.0)
5) **Little Beaver Creek** - Moderate Biodiversity, Moderate Threats and Low Protection (EC Index = 1.0)
6) **Big Dry Creek** - Moderate Biodiversity, Low Threats and Low Protection (EC Index = 1.0)
7) **Mizpah Creek** - Moderate Biodiversity, Moderate Threats and Low Protection (EC Index = 0.67)

Northwestern Great Plains Intermittent Stream (AES D005, E005)

1) **Burns Creek** - High Biodiversity, Moderate Threats and Low Protection (EC Index = 1.0)
2) **Bennie Pear Creek** - High Biodiversity, Moderate Threats and Low Protection (EC Index = 1.0)
3) **Sears Creek** - Moderate Biodiversity, Moderate Threats and Low Protection (EC Index = 0.67)
4) **Deer Creek** - High Biodiversity, High Threats and Low Protection (EC Index = 1.0)
5) **Little Dry Creek** - Moderate Biodiversity, Moderate Threats and Low Protection (EC Index = 0.67)

Northwestern Great Plains Perennial Springs (AES code S005)

1) **Cow Creek** - High Biodiversity, Moderate Threats and Moderate Protection (EC Index = 1.33)
2) **Charcoal Creek** - High Biodiversity, Moderate Threats and Low Protection (EC Index = 1.0)
3) **Stocker Branch Creek** - Moderate Biodiversity, Mod. Threats and Low Protection (EC Index = 0.67)
4) **Davis Prong Hanging Woman Creek**- Moderate Biodiversity, Moderate Threats and Moderate-Low Protection (EC Index = 1.0)

CONCLUSIONS

While Montana's portfolio sites in the NGPS ecoregion encompass many diverse and viable fish and macroinvertebrate communities, as well as all of the aquatic ecological systems identified, the effective conservation of these sites is lacking. Achieving "effective conservation" of the aquatic ecological systems contained within the portfolio sites will protect the whole of the lotic prairie aquatic biodiversity within Montana's NGPS ecoregion. In the simplest terms "effective conservation" is not being attained at most sites due to a combination of threats and very little protection. Unfortunately, even at "effectively managed" sites with a large percent of the watershed in USFWS or BLM special management status (GAP 2), landscape or local effects of management are leading to unviable or only fairly viable aquatic communities in these watersheds. At sites that are not viable, highly threatened, and not protected, or most combinations of fairly viable with any degree of threat, the determination of "not effectively conserved" is an easy one. The more difficult situation to assess is aquatic targets exhibiting high viability with low threats, but little protection.

Large Prairie and Large Valley River systems are most critical in conserving the biodiversity (due to the high proportion of specialized species), but also suffer the most cumulative anthropogenic effects. Threats from Coal Bed Natural Gas (CBNG) drilling on the Wyoming side in the Powder River basin could not be measured, but the overall threat level is immediate and severe to this watershed that is probably the last best large prairie river in the country. Immediate conservation action needs to occur in this region to maintain regional biodiversity.

Fifth code HUC watershed biointegrity ranking within the portfolio sites was positively correlated with % GAP 4 land management and negatively correlated with % managed lands in GAP 2, 1+2, or 1+2+3. While not the case in all watersheds, private unmanaged lands with higher % agriculture in the portfolio sites have a higher biological integrity than lands managed by the BLM or the USFWS, which make up the bulk of GAP 2+3 lands in this area. One explanation for this seemingly eschewed result is that local effects can far outweigh the landscape factors. If one sample from a BLM managed stream reach with repeated cattle intrusions indicate that the biological communities have poor integrity, hence viability, upstream landscape factors have little importance; the poor biological indicator scores are reflective of the condition of the reach. Alternatively, excellent biological integrity scores in one downstream section of the stream could mask upstream landscape level threats to viability given a sufficient recovery distance from the problem area. Since most sampling access points of these portfolio sites have been on public lands (e.g., BLM, USFS, State), local-scale management (i.e., improper grazing practices) could have a detrimental affect on the integrity rank of the HUC even though the landscape integrity may be high. At this scale, conservation work at the watershed level seems a logical choice, because with the entire watershed in effective management, high quality biological integrity of fish and macroinvertebrate communities will reflect the watershed health, rather than a localized portion of the stream with good in-stream habitat conditions and effective riparian zone management.

Conservation action within the Critical Sites of the Portfolio should be pursued despite challenges from threats or lack of existing effective management. These sites represent a disproportionate amount of the biodiversity occurring within the ecoregion, and may contain the best representatives of the prairie lotic aquatic ecological system types in the state. Although, other NGPS portfolio sites in adjacent states may be further along towards effective conservation, such as the South Fork of the Grand River (an excellent, viable example of the NWGP Perennial Prairie Stream in South Dakota), which were not evaluated in this pilot project.

Glossary of Terms

Aquatic Ecological Systems (AES) are stream and lake networks representing a range of areas within an ecological drainage unit with distinct geomorphological patterns tied together by similar environmental processes and communities.

Biodiversity: the word "biodiversity" is a contraction of "biological diversity" and is commonly used to describe the number, variety and variability of living organisms. Biodiversity is commonly defined in terms of the variability of genes, species and ecosystems, corresponding to these three fundamental and hierarchically related levels of biological organization.

Biodiversity Target: an element of biodiversity selected as a focus for conservation planning or action. The three principle targets are species, communities and ecological systems.

Biointegrity: measures the degree to which the biological community of a site resembles one that should be expected without anthropogenic disturbances. The degree of loss of biointegrity can indicate the extant of environmental stressors or anthropogenic disturbances that have occurred at a site. Currently, the biointegrity (condition) of a site can only be accurately determined through field inspection.

Biome: a regional ecosystem characterized by distinct types of vegetation, animals, and microbes that have developed under specific soil and climatic conditions.

Coarse-filter: an approach to assess and conserve species diversity by providing adequate representation (distribution and abundance) of ecological systems. The coarse-filter approach scores, compares and selects from among equivalent land units, terrestrial ecological systems in this case, and is often followed by and combined with a fine-filter approach.

Condition: see Biointegrity

Conservation Goal: the number and spatial distribution of occurrences of targeted species, vegetation communities and/or ecological systems considered necessary to adequately conserve the target in an ecodistrict, physiographic region or tertiary watershed.

Conservation Lands: natural areas that are managed or regulated (*e.g.*, through land-use policy) for the long-term protection of their significant natural heritage values.

Conservation Reserves: complement Provincial Parks in protecting representative natural areas and special landscapes and are regulated under the Public Lands Act. Most non-industrial resources uses (*e.g.* fur harvesting, commercial fishing and bait harvesting) are permitted if they are compatible with the values of individual reserves. Most recreational and non-commercial activities can continue in the area provided they pose little threat to the natural ecosystems and features protected by the conservation reserve.

Declining Species: exhibit significant, long-term declines in habitat and/or abundance, are subject to a high degree of threat, or may have unique habitat or behavioral requirements that expose them to a great risk.

Diversity: the variety of living organisms considered at all levels of organization including the genetic, species, and higher taxonomic levels. Biological diversity includes the variety of habitats, ecosystems and natural processes occurring within them.

Ecodistrict: a subdivision of an ecoregion characterized by distinctive assemblages of relief, geology, landforms and soils, vegetation, water, fauna, and land use.

Ecological Functions: means, in general, the natural processes, products or services that living and non-living environments provide or perform within or between species, ecosystems and landscapes. These may include biological, physical and socio-economic interactions.

Ecological System: dynamic spatial assemblages of ecological communities characterized by both biotic and abiotic components that 1) occur together on the landscape; 2) are tied together by similar ecological processes (*e.g.,* fire, hydrology), underlying environmental features (*e.g.,* soils, geology) or environmental gradients (*e.g.,* elevation, hydrologically-related zones); and 3) form a robust, cohesive, and distinguishable unit on the ground.

Element: refers to an element of biodiversity, a term used by CDCs and NatureServe to refer to the forms of biodiversity upon which CDCs and NatureServe compile information: species (including sub-species, varieties and hybrids) and natural communities.
Element Occurrence (EO): an area of land and/or water in which a species or natural community is, or was, present. An EO should have practical conservation value for the element (species or vegetation community) as evidenced by potential continued (or historical) presence and/or regular recurrence at a given location. For species, the EO often corresponds with the local population, but when appropriate may be a portion of a population (*e.g.,* long-distance dispersers) or a group of nearby populations (*e.g.,* metapopulation). The Natural Heritage Program is the central repository for Element Occurrence records.
Endemic: a species or ecological system that is restricted to a region, such as the NGPS ecoregion. Many endemic species and systems are generally considered more vulnerable to extinction due to their dependence on a single area for their survival.
EXP, Extirpated A species no longer existing in watersheds of Montana, but occurs elsewhere
EXT, Extinct A species that no longer exists
Fine-filter: an approach to assess and conserve species diversity, in conjunction with a coarse-filter approach, for viable native species and ecological communities that cannot be reliably conserved through a coarse-filter and may require individual attention. Fine-filter targets include globally imperiled species (G1 to G3G4), species at risk, endemic species, declining species, disjunct species, wide ranging species and rare vegetation communities.
Globally Imperiled Species: have been assigned a global rank of G1 or G2 by NatureServe (www.natureserve.org).
GRank (Global Rank): the overall status of a species or ecological community is regarded as its "global" status; this range-wide assessment of condition is referred to as its global conservation status rank (GRank). Global conservation status assessments are generally carried out by NatureServe scientists with input from relevant natural heritage member programs (such as the NHIC in Ontario) and experts on particular taxonomic groups, and are based on a combination of quantitative and qualitative information. The factors considered in assessing conservation status include the total number and condition of occurrences; population size; range extent and area of occupancy; short- and long-term trends in these previous factors; scope, severity, and immediacy of threats, number of protected and managed occurrences, intrinsic vulnerability and environmental specificity.
Ranking Definition
G1, Critically Imperiled At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors
G2, Imperiled At high risk of extinction due to a very restricted range, very few populations (often 20 or fewer), steep declines, or other factors
G3, Vulnerable At moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors
G4, Apparently Secure Uncommon but not rare; some cause for long-term concern due to declines
G5, Secure Common; widespread and abundant
GH Possibly extinct (species)- missing; known from only historical occurrences but still some hope of rediscovery or Presumed Eliminated (historic, ecological communities)- Presumed eliminated throughout its range, with no or virtually no likelihood that it will be rediscovered but with the potential for restoration.
GX Presumed extinct (species)- not located despite intensive searches and virtually no likelihood of rediscovery or Eliminated (ecological communities) - Eliminated throughout its range, with no restoration potential due to extinction of dominant or characteristic species
GU Unrankable, currently unrankable due to lack of information or due to substantially conflicting information about status or trends.

Limited Species: are nearly restricted to the NGPS ecoregion. These are species that are not "true" endemics because there may be populations outside the ecoregion. However, the core part of the species range is in the NGPS ecoregion.

Peripheral: species or ecological systems that are located closer to the outer boundaries of an ecoregion than to the center and are not widespread throughout the ecoregion (*e.g.*, where the Great Lakes ecoregion is the extreme edge of the species' range).

PSOC Species- Potential Species of special concern- species designated as potentially at risk of becoming SOC species by the Montana Natural Heritage Program.

Primary Targets: an element of biodiversity selected as a focus for conservation planning or action. The three main types of targets are species, communities and ecological systems.

Protected Areas: natural area designation that is regulated under legislation such as the National Parks Act, Provincial Parks Act or the Public Lands Act. Protected areas identified in the Great Lakes Conservation Blueprint include National Parks, National Wildlife Areas, Migratory Bird Sanctuaries, Provincial Parks and Conservation Reserves.

SOC Species- Species of special concern- species designated as State Endangered, Threatened or Special Concern by the Montana Natural Heritage Program.

Wide-ranging species: are highly mobile species that require large tracts of connected habitat for their survival. These include top-level predators, migratory mammals, birds and fish. The design of fully functioning networks of conservation sites needs to take into account the habitat requirements of such species, including factors such as linkages, natural corridors, interior habitats and roadless areas.

Widespread: species or ecological systems occurring naturally throughout the NGPS ecoregion and considerably beyond the ecoregion.

Literature Cited

Abell, R.A., D. M. Olson, E. Dinerstein and Patrick Hurley, eds. 2000. Freshwater Ecoregions of North America: A Conservation Assessment. World Wildlife Fund-US. Island Press, Washington, D.C.

Allan, J. D. 2004. Landscapes and riverscapes: the influence of land use on stream ecosystems. Annual Review of Ecology and Systematics 35: 257-284

Allan, J. D., D. L. Erickson and J. Fay. 1997. The influence of catchment land use on stream integrity across multiple spatial scales. Freshwater Biology 37:149-162.

Barbour, M., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadable Rivers: Periphyton, Benthic Macroinvertebrates and Fish,Second Edition. EPA 841-B-99-002. United States Environmental Protection Agency; Office of Water: Washington, D.C..

Bramblett, R. G., T. R. Johnson, A. V. Zale, A. V., and D. Heggem. 2005. Development and Evaluation of a Fish Assemblage Index of Biotic Integrity for Northwestern Great Plains. Transactions of the American Fisheries Society 134:624–640, 2005.

Bramblett, R. G., and K. D. Fausch. 1991. Variable fish communities and the index of biotic integrity in a western Great Plains river. Transactions of the American Fisheries Society 120:752–769.

Dodds, W. K., K. Gido, M. R. Whiles, K. M. Fritz, and W. J. Matthews. 2004. Life on the edge: The ecology of Great Plains prairie streams. BioScience 54: 205–216.

Ervin, J. 2003. Protected Areas in Perspective. BioScience Vol. 53 No. 9: 819-822.

Ervin, J. 2006. "Quick Guide to Protected Area Management Effectiveness." Arlington, VA: The Nature Conservancy. 12pp.

Feldman, D. 2006. Interpretation of New Macroinvertebrate Models by WQPB. Draft Report. Montana Department of Environmental Quality, Planning Prevention and Assistance Division, Water Quality Planning Bureau, Water Quality Standards Section. 1520 E. 6th Avenue, Helena, MT 59620. 14 pp.

Galat, D., C. Berry, W. Gardner, J. Hendrickson, G. Mestl, G. Power, C. Stone, and M. Winston. 2004. Spatiotemporal patterns and changes in Missouri River fishes. In J. Rine, R. Hughes, and R. Calamusso, editors. Historical changes in fish assemblages of large American Rivers. American Fisheries Society Symposium.

Hawkins, C. P. and R. H. Norris. 2000. Performance of different landscape classifications for aquatic bioassessments: introduction to the series. Journal of the North American Benthological Society. 19:3 (367-369).

Higgins, J., M. Lammert, M. Bryer, M. DePhilip, and D. Grossman. 1998. Freshwater Conservation in the Great Lakes Basin: Development and application of an aquatic Community classification framework. The Nature Conservancy, Chicago, IL.

Higgins, J., M. M. Bryer, M. Khoury and T. W. Fitzhugh. 2005. A Freshwater Classification Approach for Biodiversity Conservation Planning. Conservation Biology 19 (2): 432-445.

Holton, G. D., and H. E. Johnson. 2003. A field guide to Montana fishes, 3rd edition. Montana Fish, Wildlife, and Parks, Helena.

Jessup, B., J. Stribling; and C. Hawkins. 2005. Biological Indicators of Stream Condition in Montana Using Macroinvertebrates. Tetra Tech, Inc. November 2005 (draft).

Jessup, B. 2006. Ecological Data Application System (EDAS) Version MT 3.3. 2k A User's Guide. Tetra Tech, Inc.

Lazorchak, J.M., Klemm, D.J., and D.V. Peck (editors). 1998. Environmental Monitoring and Assessment Program - Surface Waters: Field Operations and Methods for Measuring the Ecological Condition of Wadeable Streams. EPA/620/R-94/004F. U.S. Environmental Protection Agency, Washington, D.C.

Matthews, W.J. and H.W. Robison. 1998. Influence of drainage connectivity, drainage area, and regional species richness on fishes of the Interior Highlands in Arkansas. American Midland Naturalist. 139:1-19

Montana Department of Environmental Quality (DEQ). 2005. Sample Collection, Sorting, and Taxonomic Identification of Benthic Macroinvertebrates. Water Quality Planning Bureau. Standard Operation Procedure (WQPBWQM-009).

Montana Natural Heritage Program and Fish Wildlife and Parks. 2006. Montana animal species of concern. Helena, MT: Montana Natural Heritage Program and Montana Dept. Fish Wildlife & Parks. 17 p. http://www.mtnhp.org/Reports/2006_MASOC.pdf

Montana Natural Resource Information System (NRIS). 2006. http://nris.mt.gov/gis/

Moyle, P.B., and R.A. Leidy. 1992. Loss of biodiversity in aquatic ecosystems: evidence from fish faunas. Pages 127-169. *in* Conservation Biology: the theory and practice of nature conservation, preservation and management. Chapman and Hall, New York.

The Nature Conservancy. 1999. Northern Great Plains Steppe Ecoregional Planning Team. Ecoregional Planning in the Northern Great Plains Steppe. 135 pp.

_______. 2000. Aquatic Ecoregional Planning: Measuring the Status of Biodiversity within Ecoregions. Freshwater Initiative: Draft Recommendations.

_______. 2002. Conservation by Design: A Framework for Success. www.conserveonline.org/2002/01/b/cbd#2002_01_b_sp_cbd_es_pdfTNC

_______. 2003. The Enhanced 5-S Project Management Process: An Overview of Proposed Standards for Developing Strategies, Taking Action, and Measuring Effectiveness and Status at Any Scale. The Nature Conservancy, Arlington, Virginia.

_______. 2006. Measuring the Conservation Management Status of Biodiversity within Ecoregions. Draft Issues and Recommendations.

Olivero, A.P. (author) and M.G. Anderson, and S.L. Bernstein (editors). 2003. Planning methods for ecoregional targets: Freshwater aquatic ecosystems and networks. The Nature Conservancy, Conservation Science Support, Northeast & Caribbean Division, Boston, MA.

Postel S., and B. Richter 2003. Rivers for Life: Managing Water for People and Nature. Island Press, Washington, D.C.

Salafsky, N., D. Salzer, J. Ervin, T. Boucher, and W. Ostlie. 2003. Conventions for Defining, Naming, Measuring, Combining, and Mapping Threats in Conservation: An Initial Proposal for a Standard System. www.conservationmeasures.org

Sheeder, S. A., and B. A. Evans. 2004. Estimating nutrient and sediment threshold criteria for biological impairment in Pennsylvania watersheds. Journal of the American Water Resources Association 40: 881-888.

Silk, N. and K. Ciruna, Eds. 2004. A Practitioner's Guide to Freshwater Biodiversity Conservation, The Nature Conservancy, Arlington, VA.

Scott, M.C. and G.S. Helfman. 2002. Native invasions, homogenizations and the mismeasure of integrity of fish assemblages. Fisheries 26(11) 6-15.

Stagliano, David, M. 2005. Aquatic Community Classification and Ecosystem Diversity in Montana's Missouri River Watershed. Report to the Bureau of Land Management. Montana Natural Heritage Program, Helena, Montana. 65 pp. plus appendices. http://www.mtnhp.org/reports.asp#Ecology

Stagliano, David M. 2006. Aquatic Surveys and Assessment of the Slim Buttes Region of Harding and Butte Co., SD. Report to the MT and SD TNC Field Offices. Montana Natural Heritage Program, Helena, Montana. 59 pp. plus appendices.

Suplee, M., R. Sada de Suplee, D. Feldman and T. Laidlaw 2006. Identification and Assessment of Montana Reference Streams: A Follow-up and Expansion of the 1992 Benchmark Biology Study. MT DEQ Helena, MT

Vance, L. 2005. Watershed Assessment of the Cottonwood and Whitewater Watersheds. Report to the Malta Field Office, Bureau of Land Management. Montana Natural Heritage Program, Helena, Montana. 57 pp. plus appendices.

Weitzell, R., M.L. Khoury, P. Gagnon, B. Schreurs, D. Grossman and J. Higgins. 2003. Conservation Priorities for Freshwater Biodiversity in the Upper Mississippi River Basin. NatureServe and The Nature Conservancy. 101pp + 299 pp appendices.

Wenger, S. 1999. A review of the scientific literature of riparian buffer width, extent and vegetation. Institute of Ecology, University of Georgia. Athens, GA 145pp.

White, J.L. and Harvey, B.C. 2001. Effects of an introduced piscivorous fish on native benthic fishes in a coastal river. Freshwater Biology 46(7): 987-995.

Wichert, G.A., J. MacKenzie and P. Staples. 2004. Aquatic ecosystem classification for the Great Lakes basin. Ontario Ministry of Natural Resources. Peterborough, Ontario. 78pp.

Werdon, S.J. 1992. Population status and characteristics of *Macrhybopsis gelida, Platygobio gracilis* and *Rhinichthys cataractae* in the Missouri River Basin. South Dakota State University, Brookings, SD. M.S. Thesis, 55pp.

Zheng, L., Gerritsen, J., and C. Boschen. 2005. Wadeable streams of North Dakota's Northern Glaciated Plains: Nutrient criteria development. Final Draft. Tetra Tech Inc, Owings Mills, MD. February 2005.

Appendix A. Aquatic Fine-scale Targets Tracked for this Study

Scientific Name	Common Name	G-Rank	S_Rank	MO	YELL	SPA	AES_code	Taxonomic Group	# Target EO in the Portfolio Sites	% of all EOs in the Portfolio Sites
Chelydra serpentina	Snapping Turtle	G5	S3	Localized	Localized	2	A001	reptiles	2	na
Apalone spinifera	Spiny Softshell	G5	S3	Localized	Localized	5	A001	reptiles	12	na
Anepeorus rusticus	Mayfly	G1	S1	Localized	Localized	5	A003	invertebrates	2	100%
Macdunnoa nipawinia	Mayfly	G1G3	S2	Localized	Localized	5	A001	invertebrates	4	75%
Analetris eximia	Sand mayfly	G2G4	S3	rare	Localized	5	A001	invertebrates	6	67%
Homoeoneuria alleni	Mayfly	G4	S2	Localized	Localized	5	A001	invertebrates	6	100%
Raptoheptagenia cruentata	Mayfly	G4	S2	Localized	Localized	5	A001	invertebrates	10	60%
Ametropus neavei	Mayfly	G4	S3	Localized	Localized	5	A001	invertebrates	8	75%
Lachlania saskatchewanensis	Mayfly	G4	S1	Localized	Localized	5	A001	invertebrates	4	50%
Scaphirhynchus albus	Pallid Sturgeon	G1G2	S1	Regional	Regional	5	A001	fishes	5	100%
Macrhybopsis meeki	Sicklefin Chub	G3	S1	Localized	Localized	5	A001	fishes	4	100%
Macrhybopsis gelida	Sturgeon Chub	G3	S2	Localized	Localized	5	A001, A003	fishes	11	92%
Cycleptus elongatus	Blue Sucker	G3G4	S2S3	Localized	Localized	5	A001	fishes	5	50%
Polyodon spathula	Paddlefish	G4	S1S2	Regional	Regional	5	A001	fishes	8	100%
Hybognathus hankinsoni	Brassy Minnow	G5	SU	Widespread	Widespread	18	C006	fishes	18	na
Hybognathus placitus	Plains Minnow	G5	SU	Widespread	Widespread	2	C006	fishes	22	na
Phoxinus eos	Dace	G5	SU	Widespread	Localized	4	C006	fishes	9	na
Phoxinus eos x P. neogaeus	Finescale Dace	G5	S3	Localized	n	4	C006	fishes	1	14%
Semotilus atromaculatus	Creek Chub	G5	SU	Localized	Widespread	9	B005	fishes	16	25%
Margariscus margarita	Pearl Dace	G5	S2	Localized	n	4	C006	fishes	1	5%
Noturus flavus	Stonecat	G5	S3	Widespread	Widespread	1	A001, B006	fishes	16	na
Culaea inconstans	Brook Stickleback	G5	SU	Widespread	Localized	18	C006, D006	fishes	33	na
Etheostoma exile	Iowa Darter	G5	SU	Widespread	Localized	18	C006	fishes	9	na
Stylurus intricatus	Brimstone Clubtail	G4	SU	Localized	Localized	3	A001, A003	Dragonflies	5	100%
Arigomphus cornutus	Horned Clubtail	G4	S2S4	Localized	Localized	37	A001, A003	Dragonflies	2	100%
Gomphus externus	Plains Clubtail	G5	S2S4	Widespread	Regional	5	A001	Dragonflies	5	60%
Macromia illinoiensis	Illinois River Cruiser	G5	SU	n	Localized	3	A003	Dragonflies	1	100%
									Average	76%

Appendix B. Fish and Macroinvertebrate Biointegrity Rankings for Streams within the Portfolio Sites. Ecoregion 42 = Northwestern Glaciated, 43 = Northwestern Great Plains

Stream	AES code	HUC	ECOREGION	Fish Quality	MacroQuality
Arrow Creek	B005	10040102	43	C	E
Arrow Creek	B005	10040102	43	D	E
Arrow Creek	B005	10040102	43	B	C
Arrow Creek	C001	10040102	43	B	E
Arrow Creek	C005	10040102	43	A	C
Arrow Creek	C005	10040102	43	B	C
Battle Creek	B006	10050008	42	B	B
Battle Creek	B006	10050008	42	C	B
Battle Creek	B006	10050008	42	B	B
Battle Creek	B006	10050008	42	C	C
Battle Creek	B006	10050008	42	C	C
Beaver Creek	C001	10040103	42	B	C
Beaver Creek	C001	10040103	42	B	C
Beaver Creek	C006	10050004	42	A	A
Beaver Creek	B006	10050014	42	B	E
Beaver Creek	B006	10050014	42	B	E
Beaver Creek	B006	10050014	42	B	E
Beaver Creek	C005	10090102	43	A	E
Beaver Creek	D005	10090102	43	A	E
Beaver Creek	B005	10110204	43	A	E
Beaver Creek	B005	10110204	43	A	E
Big Dry Creek	B006	10040105	43	B	E
Big Warm Creek	C006	10050014	42	B	B
Bitter Creek	D005c	10090207	43	B	E
Box Elder Creek	D001	10040103	43	E	E
Box Elder Creek	B005	10040204	43	C	E
Box Elder Creek	C005	10040204	43	B	E
Box Elder Creek	C005	10040204	43	E	B
Box Elder Creek	C005	10040204	43	E	B
Box Elder Creek	D006	10050004	42	D	C
Buggy Creek	D006	10050015	42	B	E
Cabin Creek	C005	10100004	43	A	B
Cabin Creek	C005	10100004	43	C	B
Cabin Creek	C005c	10100004	43	A	B
Cabin Creek	C005	10110202	43	D	E
Cedar Creek	C005	10100004	43	B	A
Cedar Creek	C005	10100004	43	B	B
Charcoal Creek	S005	10090102	43	E	A
Clear Creek	C006	10050004	42	A	A
Clear Creek	C005	10090206	43	B	B
Cottonwood Creek	D001	10040205	43	E	E
Cottonwood Creek	C006	10050010	42	C	C
Cottonwood Creek	C006	10050010	42	C	C
Cottonwood Creek	C006c	10050010	42	A	E
Cottonwood Creek	D006	10050013	42	E	E
Cottonwood Creek	D008	10060006	42	A	C
Cottonwood Creek	D008	10060006	42	A	B
Cottonwood Creek	D005	10100004	43	E	E
Cottonwood Creek	C005	10110201	43	C	B
Cottonwood Creek	C005	10110201	43	E	B
Cottonwood Creek	C005	10110201	43	E	B

Stream	AES code	HUC	ECOREGION	Fish Quality	MacroQuality
Cow Creek	C005	10040104	43	E	D
Cow Creek	D005	10040104	43	E	D
Cow Creek	C006	10060002	42	C	E
Cow Creek	C006	10060002	42	C	E
Cow Creek	C006	10060002	42	B	E
Cow Creek	D005	10090102	43	E	B
Cow Creek	S005	10090102	43	E	A
Cow Creek	S005	10090102	43	E	A
Cow Creek	S005	10090102	43	E	B
Cow Creek	S005	10090102	43	E	B
Crooked Creek	C005	10040205	43	B	E
Crooked Creek	C005	10040205	43	C	E
Crooked Creek	C005	10040205	43	B	E
Deer Creek	D005	10090101	43	E	B
Eagle Creek	C001	10040101	43	B	B
Eagle Creek	C006	10040101	43	B	B
Eagle Creek	C006c	10040101	43	B	B
Eagle Creek	D006	10040101	43	A	B
Eagle Creek	D008	10060006	42	A	E
Elk Creek	D005	10090102	43	E	C
Frenchman Creek	B006	10040106	43	C	C
Frenchman Creek	B006	10040106	43	C	C
Frenchman Creek	B006	10040106	43	B	A
Frenchman Creek	B006	10040106	43	B	A
Frenchman Creek	B006	10040106	43	C	B
Fish Creek	C001	10040201	43	E	C
Fish Creek	C001	10040201	43	B	E
Flat Creek	C005	10040102	43	A	E
Flat Creek	C005	10040103	43	A	B
Flat Creek	C006	10050014	41	D	E
Little Dry Creek	B005	10040106	43	C	C
Little Dry Creek	B005	10040106	43	C	C
Little Dry Creek	C005	10040106	43	C	B
Little Dry Creek	C005	10040106	43	C	C
Little Missouri River	B005	10110201	43	A	B
Little Missouri River	B005	10110201	43	B	B
Little Missouri River	B005	10110201	43	B	B
Little Missouri River	B005	10110201	43	B	B
Little Missouri River	B005	10110201	43	A	B
Little Missouri River	B005	10110201	43	B	E
Little Missouri River	B005	10110201	43	A	E
Little Powder River	B005	10090208	43	A	A
Little Powder River	B005	10090208	43	B	A
Little Powder River	B005	10090208	43	A	A
Little Powder River	B005	10090208	43	A	A
Little Powder River	B005	10090208	43	B	A
Little Powder River	B005	10090208	43	B	B
Little Powder River	B005	10090208	43	B	A

Stream	AES code	HUC	ECOREGION	Fish Quality	MacroQuality
Little Warm Creek	C006	10050014	42	B	B
Lodge Creek	C006	10050007	42	C	B
Lodge Creek	C006	10050007	42	C	B
Missouri River	A001	10040101	43	B	B
Missouri River	A001	10040101	43	B	A
Missouri River	A001	10040101	43	C	B
Missouri River	A001	10040101	43	B	B
Muddy Creek	C006	10030205	42	B	E
Muddy Creek	C006	10030205	42	B	E
Pasture Creek	D005	10090102	43	E	B
Powder River	A004	10090207	43	B	A
Powder River	A004	10090207	43	A	A
Powder River	A004	10090207	43	B	A
Powder River	A004	10090207	43	B	A
Powder River	A004	10090207	43	B	A
Pumpkin Creek	B005	10090102	43	C	C
Pumpkin Creek	B005	10090102	43	B	C
Pumpkin Creek	B005	10090102	43	C	B
Pumpkin Creek	B005	10090102	43	B	B
Pumpkin Creek	C005	10090102	43	B	C
Ranch Creek	D005	10090208	43	B	E
Rock Creek	C005	10040104	43	A	E
Rock Creek	D005	10040104	43	A	E
Rock Creek	B006	10050015	42	A	B
Rock Creek	B006	10050015	42	A	B
Rock Creek	B006	10050015	42	A	B
Rock Creek	B006	10050015	42	A	B
Rosebud Creek	C005	10100003	43	B	B
Rosebud Creek	C005	10100003	43	B	C
Rosebud Creek	C005	10100003	43	B	C
Snake Creek	D006	10050015	42	B	E
Spring Creek	D006	10050012	42	E	E
Spring Creek	S002	10090209	43	B	B
Spring Creek	S005	10090209	43	B	E
Spring Creek	S005	10090209	43	C	E
Spring Creek	S002	10100001	43	B	E
Spring Creek	S002	10110202	43	C	E
Spring Creek	S002	10110202	43	E	C
Stocker Branch Creek	S005	10090102	43	E	A
Tule Creek	C008	10060001	42	D	A
Tule Creek	C008	10060001	42	D	A
Whitewater Creek	C006	10050011	42	C	B
Whitewater Creek	C006	10050011	42	A	B
Whitewater Creek	C006	10050011	42	B	B
Willow Creek	C006	10030204	42	E	B
Willow Creek	C006	10030204	42	E	C
Willow Creek	C006	10030204	42	E	B
Willow Creek	C001	10040202	43	B	C
Willow Creek	C001	10040202	43	B	C
Willow Creek	C006	10050015	42	B	B
Willow Creek	C006	10050015	42	B	B
Willow Creek	D005	10110201	43	B	E
Willow Creek	D005	10110201	43	B	E

Stream	AES code	HUC	ECOREGION	Fish Quality	MacroQuality
Wolf Creek	C008	10060006	42	A	B
Woody Island Coulee	C006	10050010	42	A	A
Woody Island Coulee	C006	10050010	42	A	A
Woody Island Coulee	C006	10050010	42	A	A
Woody Island Coulee	C006	10050010	42	B	E
Woody Island Coulee	D006	10050010	42	B	E
Yellowstone River	A002	10070004	43	B	B
Yellowstone River	A002	10070006	43	B	B
Yellowstone River	A002	10070006	43	B	B
Yellowstone River	A002	10070006	43	B	A
Yellowstone River	A002	10070006	43	C	B
Yellowstone River	A002	10100004	43	B	B
Yellowstone River	A002	10100004	43	B	B
Yellowstone River	A002	10100004	43	B	B
Yellowstone River	A002	10100004	43	B	A
Yellowstone River	A002	10100004	43	B	B
Yellowstone River	A002	10100004	43	B	A
Yellowstone River	A002	10100004	43	B	B
Yellowstone River	A002	10100004	43	B	B
Yellowstone River	A002	10100004	43	C	B

Appendix C. MT DEQ Reference Streams within or Tributaries to the Portfolio Sites

Stream Name	REF SITE No	Ref Site Source	LAT(DD)	LONG(DD)
Arrow Creek	ArrowCre_135_W	Dave Stagliano(NHP)	47.6256	-109.8356
Basin Creek	BasinCre_001_C	MT DEQ	46.6756	-110.4389
Beauvais Creek	Beauvais_131_W	MT DEQ	45.4769	-108.0081
Beauvois Creek	Beauvois_136_W	Dave Stagliano(NHP)	45.4432	-108.1628
Beaver Creek	BeaverCr_002_W	MT DEQ	47.0794	-109.5989
Bitter Creek	BitterCr_120_W	MT DEQ	48.6489	-106.9025
Box Elder Creek	BoxElder_013_W	MT DEQ	45.8444	-104.1439
Calf Creek	CalfCree_017_C	MT DEQ	46.8450	-110.9600
Cedar Creek	CedarCr9_140_W	Dave Stagliano(NHP)	46.7917	-104.5583
Clear Creek	ClearCre_121_W	MT DEQ	48.3061	-109.4906
Cottonwood Creek	Cottonwo_021_C	MT DEQ	44.9425	-112.4294
Cow Creek	CowCreek_022_W	MT DEQ	47.8611	-108.9633
Cow Creek	CowCreek_141_W	Dave Stagliano(NHP)	45.3092	-106.2497
CROOKED CREEK	crookd99_200_C	Chuck Hawkins (USU)	45.1334	-108.4280
CROOKED CREEK	CROOKEDC_111_C	MT DEQ	45.0433	-108.3850
Eagle Creek	EagleCre_030_W	MT DEQ	47.9211	-110.0350
Eagle Creek	EagleCre_028_C	MT DEQ	48.1008	-109.7689
East Redwater Creek	E.Redwat_027_W	MT DEQ	47.7581	-104.9228
Fish Creek	FishCree_038_W	MT DEQ	46.2506	-109.7689
Fourmile Creek	Fourmile_112_C	MT DEQ	45.3408	-110.2464
Highwood Creek	Highwood_044_W	MT DEQ	47.4994	-110.7164
Little Dry Creek	LittleDr_151_W	Dave Stagliano(NHP)	47.3413	-106.3630
Little Missouri River	LittleMi_152_W	REMAP	44.9952	-104.4235
Little Powder River	LittlePo_050_W	MT DEQ	45.3189	-105.3178
Muddy Creek	MuddyCre_057_W	MT DEQ	45.4328	-107.9619
O'Fallon Creek	OFallon9_156_W	REMAP	46.4707	-104.7699
O'Fallon Creek	OFallonC_062_W	MT DEQ	46.4711	-104.7697
O'Fallon Creek	OFallon9_157_W	REMAP	46.7350	-105.0574
Pasture Creek	PastureC_064_W	MT DEQ	47.7064	-105.2456
Pasture Creek	PastureC_065_W	MT DEQ	47.6397	-105.1617
Pumpkin Creek	PumpkinC_161_W	REMAP	46.1890	-105.6217
Rock Creek	RockCree_123_W	MT DEQ	48.8758	-106.8967
Rock Creek	RockCree_124_W	MT DEQ	48.5903	-107.0011
Rock Creek	RockCrBL_122_W	MT DEQ	48.6569	-107.0389
Rock Creek	ROCKCREE_125_W	MT DEQ	48.8789	-106.8992
Rock Creek	ROCKCREE_133_W	MT DEQ	48.9694	-106.8389
Tule Creek	TuleCree_092_W	MT DEQ	48.2236	-105.5175
Tule Creek	TuleCree_164_W	REMAP	48.1836	-105.4915
West Fork Poplar River	WFkPopla_126_W	MT DEQ	48.6970	-105.8319
West Fork Poplar River	WESTFORK_127_W	MT DEQ	48.9442	-106.2503
West Fork Poplar River	WESTFORK_129_W	MT DEQ	48.7478	-105.9286
West Fork Poplar River	WESTFORK_128_W	MT DEQ	48.8081	-106.0206
West Fork Poplar River	WESTFORK_099_W	MT DEQ	48.6225	-105.6525
Whitewater Creek	Whitewat_170_W	Dave Stagliano(NHP)	48.9566	-107.8594
Whitewater Creek	Whitewat_169_W	REMAP	48.6001	-107.5195
Willow Creek	WillowCr_171_W	REMAP	48.5847	-106.9625
Willow Creek	WillowCr_172_W	Dave Stagliano(NHP)	48.7567	-111.5216
Wolf Creek	WolfCree_130_W	MT DEQ	48.0878	-105.6781
Woody Island Coulee	WoodyIsl_174_W	REMAP	48.9227	-108.3795
Yellowstone River	Yellowst_276_C	Chuck Hawkins (USU)	46.5395	-110.5820

Appendix D. Common Threats Taxonomy (Conservation Measures Group 2006)

1. **HABITAT CONVERSION AND DEGRADATION,** including complete loss of or damage to natural habitats.
   a. **Housing & Urban Development** – Expansion of human cities, towns, and settlements including non-housing development typically integrated with housing (urban, suburbs, villages, ranchettes, vacation homes, shopping areas, offices, etc.)
   b. **Commercial & Industrial Development** – Factories and other commercial centers (factories, shopping centers, train yards, docks, ship yards, airports, landfills)
   c. **Farms & Plantations** – Agricultural operations (commercial farms, plots, industrial plantations, feed lots, aquaculture)
   d. **Recreation Areas –** Recreation sites with a substantial footprint (ski areas, golf courses, resorts, cricket fields, county parks)
   e. **Military Activities –** Actions by formal or paramilitary forces with a substantial footprint (armed conflict, military bases, large-scale training exercises, testing)
   f. **Natural System Modifications** – Actions that convert or degrade habitat in service of "managing" natural systems to improve human welfare (flooding from dam construction, land reclamation projects, wetland filling for mosquito control, rip-rap along shoreline, levees and dikes).
   g. **Altered Fire Regime** – Suppression or increase in fire frequency and/or intensity outside of its natural range of variation (fire suppression, inappropriate fire management, escaped agricultural fires, arson, campfires, fires for hunting)
   h. **Altered Hydrologic Regime** – Changing water flow patterns outside their natural range of variation (surface water diversion, groundwater pumping, dam operations).

2. **TRANSPORTATION INFRASTRUCTURE,** Long narrow corridors and the vehicles that use them that potentially alter, fragment, and disturb natural habitat and species.
   a. **Roads** – Surface transport on roadways (highways, primary roads, secondary roads, primitive roads, logging roads, roadkill).
   b. **Railroads –** Surface transport on dedicated tracks (freight/passenger lines)
   c. **Utility Lines –** Transport of energy & resources (electrical & phone wires, aqueducts, oil & gas pipelines)

3. **ENERGY AND MINING,** including production of non-biological resources.
   a. **Oil & Gas Drilling** – Exploring, developing, and producing petroleum and other liquid hydrocarbons (oil wells, gas wells)
   b. **Mining** – Exploring, developing, and producing minerals (coal strip mines, alluvial gold panning, diamond mines, rock quarries, sand and salt mines)
   c. **Renewable Energy** – Exploring, developing, and producing renewable energy (geothermal, solar farms, wind farms, tidal farms)

4. **BIOLOGICAL RESOURCE HARVESTING**, including the consumptive use of "wild" resources.
   a. **Hunting, Trapping & Fishing** – Harvesting wild animals for commercial, recreation, subsistence, research, or management purposes (commercial hunting, trophy hunting, trawling, fur trapping, whaling, butterfly collecting)

b. **Gathering** – Harvesting plants, fungi, and other non-timber/non-animal products for commercial, recreation, or subsistence purposes (mushrooms, forage for stall fed animals, fuelwood collection)
c. **Logging –** Harvesting timber (clear cutting, selective commercial logging)
d. **Grazing & Ranching** – Using natural habitats to support domestic or semi-domesticated animals that are allowed to roam in the wild (livestock, hatchery salmon)
e. **Recreation & Work in Natural Habitats –** Non-consumptive uses of biological resources.
f. **Motor-Powered Recreation & Work** – Vehicles and boats traveling outside of established transport corridors (off-road vehicles, ATVs, motorboats, motorcycles, jetskis, snowmobiles, ultralight planes, dive boats, tanks & other military vehicles)
g. **Human-Powered Recreation & Work** – People spending time in nature (mountain bikes, hikers, cross-country skiers, hangliders, birdwatchers, scuba divers)

6. **POLLUTION,** including the introduction of exotic and/or excess materials from point and nonpoint sources.
   a. **Chemicals & Toxins** – Industrial chemicals and toxins in the air, land, and water (mercury from goldmines, heavy metals, PCBs, acid rain, smog, ozone depleters, oil from cars, chemical dumping, oil spills, agricultural pesticides, lead bullets)
   b. **Nutrient Loads** – Excess nutrients (nitrogen from farms or municipal sewage phosphates from detergents)
   c. **Solid Waste** – Garbage and other materials (garbage, litter, flotsam & jetsam)
   d. **Waste & Residual Materials** – Large-scale by-products of development or resource use activities (dredge spoil, water treatment residuals, logging slash, mine tailings, excess sediment loads)
   e. **Greenhouse Gasses** – Gasses that alter atmospheric composition (CO_2, methane)
   f. **Radioactive Materials** – Radioactive materials (bomb fallout, nuclear power waste)
   g. **Salt** – Excess salt (snow removal chemicals, residue from irrigation)
   h. **Sonic Pollution –** Excess noise (noise from highways, airplanes, sonar)
   i. **Thermal Pollution** – Excess heat (heat from power plants)
   j. **Light Pollution** – Artificial light that disturbs animals and disrupts migration

7. **INVASIVE AND OTHER PROBLEMATIC SPECIES AND GENES,** including non-native and native species or genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance.
   a. **Invasive Species** – Harmful non-native species not originally found within the ecosystem(s) in question and directly or indirectly introduced and spread into it by human activities
   b. **Problematic Native Species** – Harmful species that are originally found within the ecosystem(s) in question, but have become “out-of-balance” or “released” directly or indirectly due to human activities
   c. **Introduced Genetic Material –** Human-altered or created organisms and genes (pesticide resistant crops, genetically modified insects, genetically modified trees, genetically modified salmon)
   d. **Species Hybridization** – Human-caused species hybridization (plants, birds)

Appendix E. Master HUC GIS Threats Rank Data for the Selected Portfolio Sites

Portfolio Site	FIFTHCODE	%Graze Rank	%Ag Rank	Stream RD rank	Stream Intersec Rank	Dams_rank	Oil Gas_rank	Surface Div_rank	Additive Threat	Northern Pike Rank	Syn Threat	Additive Rank	Syn RANK
Frenchman/Bitter Creek	10050004230	2	4	2	4	1	3	3	19	3	8	3	2
Frenchman/Bitter Creek	10050004240	1	4	2	2	1	5	3	18	3	8	3	2
Frenchman/Bitter Creek	10050011010	2	4	2	3	1	5	5	22	1	4	4	1
Frenchman/Bitter Creek	10050011020	2	4	3	4	1	5	5	24	3	8	4	2
Frenchman/Bitter Creek	10050012010	3	4	1	2	1	2	3	16	2	6	3	2
Frenchman/Bitter Creek	10050012020	3	3	1	3	1	1	4	16	2	6	3	2
Frenchman/Bitter Creek	10050012050	2	4	4	4	2	2	4	22	3	10	4	3
Frenchman/Bitter Creek	10050013010	3	4	4	4	1	4	5	25	3	8	4	3
Frenchman/Bitter Creek	10050015010	2	4	1	0	1	1	3	12	2	6	2	2
Frenchman/Bitter Creek	10050015020	3	4	1	2	1	1	4	16	2	6	3	2
Frenchman/Bitter Creek	10050015030	3	4	1	1	1	1	1	12	2	6	2	2
Frenchman/Bitter Creek	10050015040	3	2	1	1	0	1	3	11	2	4	2	1
Frenchman/Bitter Creek	10050015050	3	1	1	1	1	1	3	11	2	6	2	2
Frenchman/Bitter Creek	10050015060	3	3	2	2	1	1	3	15	2	6	2	2
Frenchman/Bitter Creek	10050015070	2	3	1	1	0	1	3	11	1	2	2	1
Frenchman/Bitter Creek	10050015080	3	1	1	1	0	1	3	10	1	2	1	1
Frenchman/Bitter Creek	10050015090	3	1	1	0	0	1	2	8	1	2	1	1
Frenchman/Bitter Creek	10050015100	3	2	1	1	1	1	3	12	1	4	2	1
Frenchman/Bitter Creek	10050015110	2	4	3	4	1	3	5	22	2	6	4	2
Frenchman/Bitter Creek	10050016040	2	4	1	3	1	2	5	18	2	6	3	2
Frenchman/Bitter Creek	10060004010	1	4	1	2	0	0	2	10	1	2	1	1
Hell Creek Badlands	10040104220	2	1	2	4	1	1	4	15	1	4	2	1
Hell Creek Badlands	10040104240	3	2	1	1	2	1	1	11	1	6	2	2
Hell Creek Badlands	10040104290	2	1	1	2	1	1	4	12	2	6	2	2
Hell Creek Badlands	10040105070	3	2	3	4	4	1	4	21	2	12	4	3
Hell Creek Badlands	10040106080	3	4	3	4	2	1	4	21	1	6	4	2
Montana Glaciated Plains	10040104080	2	1	2	3	1	1	3	13	1	4	2	1
Montana Glaciated Plains	10040104090	1	1	1	3	1	2	5	14	1	4	2	2
Montana Glaciated Plains	10040104100	2	1	2	3	1	1	3	13	1	4	2	1
Montana Glaciated Plains	10040104110	2	1	1	2	1	1	5	13	1	4	2	1
Montana Glaciated Plains	10040104130	1	1	1	2	1	1	5	12	1	4	2	1
Montana Glaciated Plains	10040104140	2	2	1	2	1	1	5	14	1	4	2	1
Montana Glaciated Plains	10040104150	2	4	2	3	3	1	5	20	1	8	3	2
Montana Glaciated Plains	10040104170	1	1	1	1	0	0	4	8	2	4	1	1
Montana Glaciated Plains	10040104180	2	1	2	3	0	1	3	12	2	4	2	1
Montana Glaciated Plains	10040104190	2	1	1	1	0	0	4	9	2	4	1	1
Montana Glaciated Plains	10040104210	2	1	1	3	0	0	3	10	1	2	1	1
Montana Glaciated Plains	10040104230	1	1	1	1	1	0	4	9	1	4	1	1
Montana Glaciated Plains	10050004150	2	4	1	3	1	1	1	13	2	6	2	1
Montana Glaciated Plains	10050004160	2	4	4	4	2	4	5	25	3	10	4	3
Montana Glaciated Plains	10050004190	2	4	4	4	4	1	5	24	1	10	4	3
Montana Glaciated Plains	10050009010	2	4	0	4	1	0	1	12	2	6	2	1
Montana Glaciated Plains	10050009020	1	4	4	4	3	3	5	24	2	10	4	3
Montana Glaciated Plains	10050009030	2	4	4	4	1	1	2	18	2	6	3	2
Montana Glaciated Plains	10050012030	2	4	2	3	1	2	4	18	2	6	3	2
Montana Glaciated Plains	10050012040	1	4	4	4	2	3	4	22	3	10	4	2
Montana Glaciated Plains	10050012060	2	4	1	3	1	1	4	16	2	6	3	2
Montana Glaciated Plains	10050012070	3	1	1	2	2	1	4	14	2	8	2	2
Montana Glaciated Plains	10050012080	2	1	1	2	1	1	4	12	1	4	2	1
Montana Glaciated Plains	10050012090	3	3	3	4	4	1	5	23	2	12	4	3
Montana Glaciated Plains	10050014010	3	4	4	4	4	1	5	25	2	12	4	3
Montana Glaciated Plains	10050014020	2	4	4	4	4	2	5	25	2	12	4	3
Montana Glaciated Plains	10050014030	2	4	1	2	1	1	5	16	2	6	3	2
Montana Glaciated Plains	10050014040	2	4	1	3	1	1	5	17	2	6	3	2
Montana Glaciated Plains	10050014050	3	2	4	4	2	4	5	24	2	8	4	2
Montana Glaciated Plains	10050014070	2	4	4	4	2	5	5	26	3	10	4	3
Sage Creek/SW Pastures	10050002060	1	4	4	4	4	5	4	26	1	10	4	3
Sage Creek/SW Pastures	10050003010	1	4	1	1	1	2	1	11	1	4	2	1
Sage Creek/SW Pastures	10050004060	2	4	3	4	1	5	5	24	2	6	4	2
Sage Creek/SW Pastures	10050004070	3	4	1	3	1	4	3	19	1	4	3	2
Sage Creek/SW Pastures	10050004120	3	4	3	4	1	4	5	24	2	6	4	2
Sage Creek/SW Pastures	10050007010	2	4	4	4	4	5	5	28	3	14	4	4
Sage Creek/SW Pastures	10050008010	3	4	2	3	1	3	5	21	2	6	4	2
Sage Creek/SW Pastures	10050008020	3	4	4	4	1	4	5	25	3	8	4	2
Sage Creek/SW Pastures	10050008030	2	4	3	4	4	5	5	27	3	14	4	4
Sage Creek/SW Pastures	10050010010	1	4	3	4	1	2	4	19	1	4	3	1
Whitewater Wetlands	10050004210	1	4	1	2	1	2	5	16	3	8	3	2
Whitewater Wetlands	10050010020	1	4	2	3	1	2	5	18	1	4	3	1

Portfolio Site	FIFTHCODE	Acres HUC	% Riparian grazing	P_Agriculture w/i Site	Stream Miles w/i 40m of Roads	Intersect Roads & Streams	Count of Dams	Count of Oil & Gas Wells	Count of Surface Diversions	Northern Pike
Frenchman/Bitter Creek	10050004230	61,626	6.0	35.1	1.7	50	1	56	177	3
Frenchman/Bitter Creek	10050004240	52,263	2.8	57.7	1.8	27	2	214	118	3
Frenchman/Bitter Creek	10050011010	121,712	4.2	26.9	1.1	35	3	309	1,629	1
Frenchman/Bitter Creek	10050011020	217,424	3.3	22.5	2.8	78	5	715	2,810	3
Frenchman/Bitter Creek	10050012010	52,172	6.8	19.7	0.6	17	2	13	130	2
Frenchman/Bitter Creek	10050012020	88,125	7.2	5.4	0.8	24	1	9	340	2
Frenchman/Bitter Creek	10050012050	88,630	5.0	35.9	4.4	58	7	22	247	3
Frenchman/Bitter Creek	10050013010	171,398	7.2	11.9	3.1	91	2	115	500	3
Frenchman/Bitter Creek	10050015010	31,121	5.5	11.1	0.4	0	2	1	117	2
Frenchman/Bitter Creek	10050015020	61,148	6.6	10.2	0.5	15	2	5	213	2
Frenchman/Bitter Creek	10050015030	14,474	7.2	16.9	0.1	4	1	1	36	2
Frenchman/Bitter Creek	10050015040	28,419	6.5	3.6	0.1	2	0	2	120	2
Frenchman/Bitter Creek	10050015050	45,496	8.9	0.3	0.3	10	1	6	153	2
Frenchman/Bitter Creek	10050015060	42,997	7.9	17.6	1.2	23	2	6	119	2
Frenchman/Bitter Creek	10050015070	56,780	5.9	8.7	0.2	6	0	4	103	1
Frenchman/Bitter Creek	10050015080	37,146	6.4	2.4	0.1	2	0	3	111	1
Frenchman/Bitter Creek	10050015090	43,806	6.3	0.6	0.1	0	0	2	72	1
Frenchman/Bitter Creek	10050015100	49,143	6.7	4.7	0.3	8	2	5	138	1
Frenchman/Bitter Creek	10050015110	143,565	6.0	22.2	2.1	57	1	21	515	2
Frenchman/Bitter Creek	10050016040	182,296	4.3	30.2	1.1	37	1	16	502	2
Frenchman/Bitter Creek	10060004010	44,063	2.7	60.0	0.6	16	0	0	97	1
Hell Creek Badlands	10040104220	240,280	5.4	2.0	1.7	51	5	1	516	1
Hell Creek Badlands	10040104240	36,698	7.1	3.6	0.3	10	7	3	62	1
Hell Creek Badlands	10040104290	109,380	5.9	1.1	0.6	16	4	2	310	2
Hell Creek Badlands	10040105070	177,516	8.6	4.7	3.0	94	31	7	311	2
Hell Creek Badlands	10040106080	97,191	7.9	21.1	3.7	120	7	4	219	1
Montana Glaciated Plains	10040104080	62,560	5.5	0.8	1.0	31	2	10	156	1
Montana Glaciated Plains	10040104090	188,085	3.0	1.6	0.8	26	2	18	333	1
Montana Glaciated Plains	10040104100	79,941	4.8	1.1	1.3	36	2	1	139	1
Montana Glaciated Plains	10040104110	121,080	6.0	1.4	0.5	17	3	4	338	1
Montana Glaciated Plains	10040104130	188,090	2.5	0.1	0.5	13	5	3	377	1
Montana Glaciated Plains	10040104140	89,777	5.1	4.5	0.6	16	5	2	301	1
Montana Glaciated Plains	10040104150	134,201	5.0	11.5	1.6	46	16	10	549	1
Montana Glaciated Plains	10040104170	112,729	2.5	0.5	0.5	4	0	0	235	2
Montana Glaciated Plains	10040104180	95,414	6.2	1.6	2.0	42	0	2	141	2
Montana Glaciated Plains	10040104190	84,737	3.2	0.5	0.1	3	0	0	172	2
Montana Glaciated Plains	10040104210	114,653	3.4	1.8	0.8	23	1	0	191	1
Montana Glaciated Plains	10040104230	104,431	0.9	0.4	0.2	5	2	0	265	1
Montana Glaciated Plains	10050004150	106,068	4.9	26.7	1.0	36	4	5	35	2
Montana Glaciated Plains	10050004160	189,299	2.8	25.3	5.4	137	8	37	331	3
Montana Glaciated Plains	10050004190	134,645	3.3	30.2	3.4	95	13	2	556	1
Montana Glaciated Plains	10050009010	152,186	5.7	13.8	7.2	139	2	0	25	2
Montana Glaciated Plains	10050009020	172,752	2.6	20.8	4.1	102	10	24	778	2
Montana Glaciated Plains	10050009030	130,615	4.6	19.8	3.1	61	1	3	95	2
Montana Glaciated Plains	10050012030	65,063	5.9	9.3	1.8	41	1	13	204	2
Montana Glaciated Plains	10050012040	117,887	1.6	51.7	4.6	82	9	31	279	3
Montana Glaciated Plains	10050012060	72,932	4.8	14.9	1.0	32	4	7	204	2
Montana Glaciated Plains	10050012070	72,662	6.4	2.5	0.6	19	6	2	260	2
Montana Glaciated Plains	10050012080	83,676	4.5	0.3	0.6	18	1	5	221	1
Montana Glaciated Plains	10050012090	195,118	7.2	8.7	2.4	75	12	6	599	2
Montana Glaciated Plains	10050014010	199,648	6.6	15.6	6.1	122	14	9	549	2
Montana Glaciated Plains	10050014020	185,188	5.0	11.9	4.1	83	23	12	937	2
Montana Glaciated Plains	10050014030	83,114	3.9	10.7	0.4	12	5	1	382	2
Montana Glaciated Plains	10050014040	90,937	4.6	14.4	0.8	28	2	2	448	2
Montana Glaciated Plains	10050014050	242,145	6.2	5.4	4.3	126	7	93	1,013	2
Montana Glaciated Plains	10050014070	278,891	4.0	35.4	8.4	175	8	335	914	3
Sage Creek/SW Pastures	10050002060	198,017	2.9	73.7	6.5	164	12	100	206	1
Sage Creek/SW Pastures	10050003010	55,917	0.9	50.3	0.2	8	2	17	37	1
Sage Creek/SW Pastures	10050004060	89,257	3.8	60.4	2.1	70	5	195	288	2
Sage Creek/SW Pastures	10050004070	34,302	6.6	20.4	0.9	27	4	45	198	1
Sage Creek/SW Pastures	10050004120	87,068	8.2	14.7	2.9	61	2	84	390	2
Sage Creek/SW Pastures	10050007010	160,016	5.0	53.0	3.4	110	15	157	613	3
Sage Creek/SW Pastures	10050008010	69,151	7.6	12.8	1.7	42	2	21	445	2
Sage Creek/SW Pastures	10050008020	124,221	6.9	20.9	3.1	82	3	141	662	3
Sage Creek/SW Pastures	10050008030	110,277	5.6	21.6	2.4	68	15	259	564	3
Sage Creek/SW Pastures	10050010010	143,043	2.9	50.7	2.7	72	2	16	323	1
Whitewater Wetlands	10050004210	143,930	1.7	38.3	0.7	22	1	20	1,374	3
Whitewater Wetlands	10050010020	183,150	1.9	52.9	1.5	39	1	14	2,288	1

Appendix F. Master HUC GIS GAP Status Data for the Selected Portfolio Sites

Portfolio Site	FIFTHCODE	% in GAP 1	% in GAP 2	% in GAP 3	% in GAP 4	% in GAP 1+2	% in GAP 1+2+3	Permanently Secured Lands	Effective Conservation Management
Frenchman/Bitter Creek	10050004230	0.0	0.0	19.2	80.7	0.0	19.3	1	0
Frenchman/Bitter Creek	10050004240	0.0	0.0	9.1	90.9	0.0	9.1	1	0
Frenchman/Bitter Creek	10050011010	0.0	0.0	61.6	38.5	0.0	61.5	2	0
Frenchman/Bitter Creek	10050011020	0.0	0.4	55.5	44.5	0.4	55.5	2	0
Frenchman/Bitter Creek	10050012010	0.0	0.0	55.9	44.0	0.0	56.0	2	0
Frenchman/Bitter Creek	10050012020	0.0	4.1	75.0	26.2	4.1	73.8	2	0
Frenchman/Bitter Creek	10050012050	0.0	0.0	50.2	49.7	0.0	50.3	2	0
Frenchman/Bitter Creek	10050013010	0.0	0.0	41.7	58.3	0.0	41.7	1	0
Frenchman/Bitter Creek	10050015010	0.0	0.0	56.2	44.4	0.0	55.6	2	0
Frenchman/Bitter Creek	10050015020	0.0	0.0	74.0	27.7	0.0	72.3	2	0
Frenchman/Bitter Creek	10050015030	0.0	0.0	56.6	43.4	0.0	56.6	2	0
Frenchman/Bitter Creek	10050015040	0.0	0.0	70.8	30.9	0.0	69.1	2	0
Frenchman/Bitter Creek	10050015050	0.0	0.0	98.5	6.3	0.0	93.7	3	0
Frenchman/Bitter Creek	10050015060	0.0	0.0	54.4	46.5	0.0	53.5	2	0
Frenchman/Bitter Creek	10050015070	0.0	53.9	69.0	34.3	53.9	65.7	2	1
Frenchman/Bitter Creek	10050015080	0.0	3.2	104.4	0.0	3.2	100.0	3	0
Frenchman/Bitter Creek	10050015090	0.0	1.0	97.2	5.7	1.0	94.3	3	0
Frenchman/Bitter Creek	10050015100	0.0	33.2	67.5	35.2	33.2	64.8	2	1
Frenchman/Bitter Creek	10050015110	0.0	0.0	53.9	47.2	0.0	52.8	2	0
Frenchman/Bitter Creek	10050016040	0.0	0.1	34.7	65.7	0.1	34.3	1	0
Frenchman/Bitter Creek	10060004010	0.0	0.0	6.2	93.8	0.0	6.2	1	0
Hell Creek Badlands	10040104220	0.0	38.4	46.8	16.8	38.4	83.2	3	1
Hell Creek Badlands	10040104240	0.0	2.0	64.5	33.9	2.0	66.1	2	0
Hell Creek Badlands	10040104290	0.0	37.7	57.3	7.4	37.7	92.6	3	1
Hell Creek Badlands	10040105070	0.0	1.8	42.8	55.6	1.8	44.4	1	0
Hell Creek Badlands	10040106080	0.0	0.0	19.8	80.1	0.0	19.9	1	0
Montana Glaciated Plains	10040104080	0.1	21.5	50.9	28.8	21.6	71.2	2	0
Montana Glaciated Plains	10040104090	2.4	83.1	39.4	16.1	85.6	83.9	3	2
Montana Glaciated Plains	10040104100	0.0	22.3	35.5	43.9	22.3	56.1	2	1
Montana Glaciated Plains	10040104110	13.1	19.4	64.8	18.9	32.4	81.1	3	1
Montana Glaciated Plains	10040104130	0.4	70.7	30.2	8.1	71.1	91.9	3	2
Montana Glaciated Plains	10040104140	0.0	39.8	50.4	17.0	39.8	83.0	3	1
Montana Glaciated Plains	10040104150	0.0	7.5	50.9	42.4	7.5	57.6	2	0
Montana Glaciated Plains	10040104170	0.0	66.4	32.6	5.8	66.4	94.2	3	2
Montana Glaciated Plains	10040104180	0.0	19.6	72.6	16.0	19.6	84.0	3	0
Montana Glaciated Plains	10040104190	0.0	84.6	37.4	8.3	84.6	91.7	3	2
Montana Glaciated Plains	10040104210	0.0	59.4	37.2	4.9	59.4	95.1	3	2
Montana Glaciated Plains	10040104230	2.4	46.2	49.7	6.2	48.6	93.8	3	1
Montana Glaciated Plains	10050004150	0.0	0.0	9.2	96.4	0.0	3.6	1	0
Montana Glaciated Plains	10050004160	0.0	0.1	12.7	88.1	0.1	11.9	1	0
Montana Glaciated Plains	10050004190	0.0	0.6	34.9	64.4	0.6	35.6	1	0
Montana Glaciated Plains	10050009010	0.0	0.0	7.9	93.5	0.0	6.5	1	0
Montana Glaciated Plains	10050009020	0.0	0.0	14.8	86.1	0.0	13.9	1	0
Montana Glaciated Plains	10050009030	0.0	0.7	6.2	96.5	0.7	3.5	1	0
Montana Glaciated Plains	10050012030	0.0	0.0	49.6	50.4	0.0	49.6	1	0
Montana Glaciated Plains	10050012040	0.0	2.9	23.8	73.2	2.9	26.8	1	0
Montana Glaciated Plains	10050012060	0.0	0.0	66.9	33.0	0.0	67.0	2	0
Montana Glaciated Plains	10050012070	0.0	0.0	99.1	0.8	0.0	99.2	3	0
Montana Glaciated Plains	10050012080	0.0	29.5	98.1	1.8	29.5	98.2	3	1
Montana Glaciated Plains	10050012090	0.0	3.2	79.6	17.2	3.2	82.8	3	0
Montana Glaciated Plains	10050014010	5.0	0.4	26.0	70.1	5.4	29.9	1	0
Montana Glaciated Plains	10050014020	15.1	3.3	37.4	47.0	18.4	53.0	2	0
Montana Glaciated Plains	10050014030	0.0	0.0	60.1	39.8	0.0	60.2	2	0
Montana Glaciated Plains	10050014040	0.0	0.0	54.4	45.5	0.0	54.5	2	0
Montana Glaciated Plains	10050014050	0.0	0.0	62.9	37.0	0.0	63.0	2	0
Montana Glaciated Plains	10050014070	0.0	1.1	30.4	68.5	1.1	31.5	1	0
Sage Creek/SW Pastures	10050002060	0.0	0.0	21.2	80.2	0.0	19.8	1	0
Sage Creek/SW Pastures	10050003010	0.0	0.0	27.2	72.8	0.0	27.2	1	0
Sage Creek/SW Pastures	10050004060	0.0	3.1	15.7	81.1	3.1	18.9	1	0
Sage Creek/SW Pastures	10050004070	0.0	12.4	30.1	57.5	12.4	42.5	1	0
Sage Creek/SW Pastures	10050004120	0.0	0.0	35.3	64.7	0.0	35.3	1	0
Sage Creek/SW Pastures	10050007010	0.0	12.4	30.1	57.5	12.4	42.5	1	0
Sage Creek/SW Pastures	10050008010	0.0	15.4	44.9	39.7	15.4	60.3	2	0
Sage Creek/SW Pastures	10050008020	0.0	0.2	37.4	62.3	0.2	37.7	1	0
Sage Creek/SW Pastures	10050008030	0.0	0.4	31.3	68.3	0.4	31.7	1	0
Sage Creek/SW Pastures	10050010010	0.0	0.0	14.6	85.4	0.0	14.6	1	0
Whitewater Wetlands	10050004210	0.0	1.2	34.3	64.5	1.2	35.5	1	0
Whitewater Wetlands	10050010020	0.0	0.1	29.0	70.9	0.1	29.1	1	0